Telegraphic Address: "Agocky London." A B C Code. [Registered at G.P.O. as a Newspaper.

Vol. XXVIII.
No. 689.

FEBRUARY 6, 1891.

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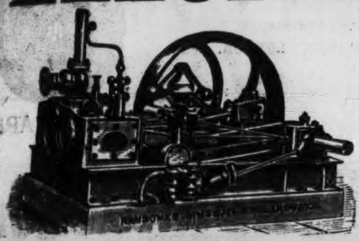

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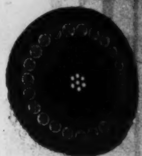

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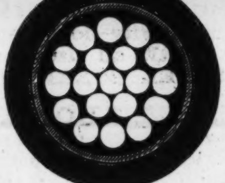

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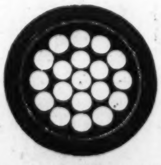

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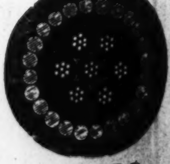

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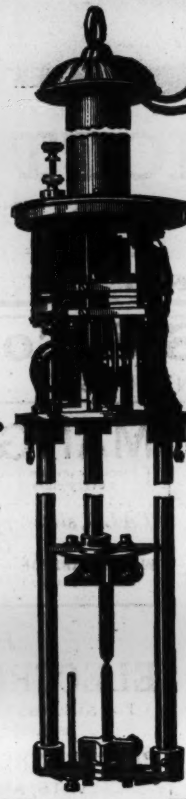

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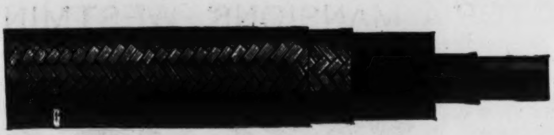

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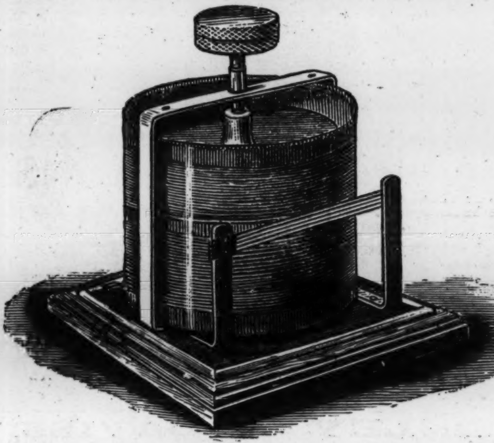

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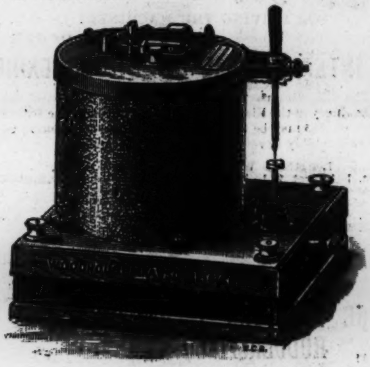

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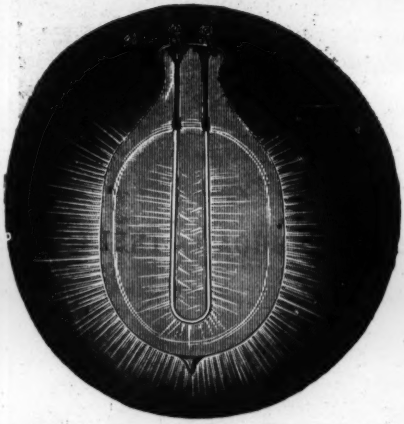

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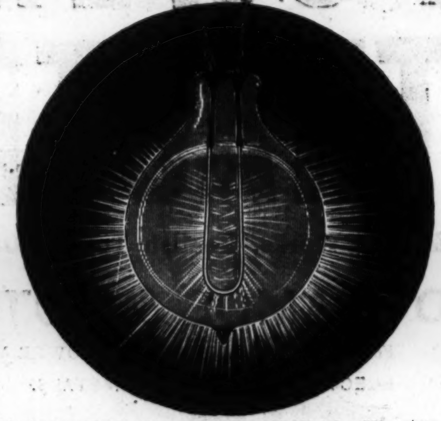

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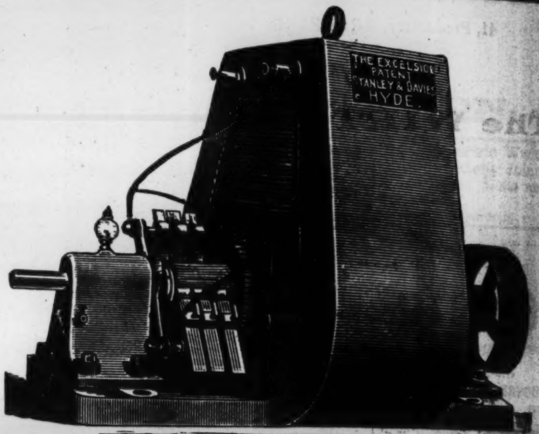
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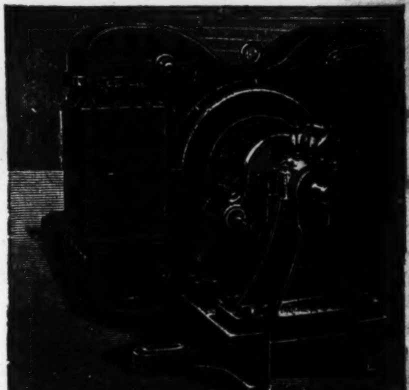

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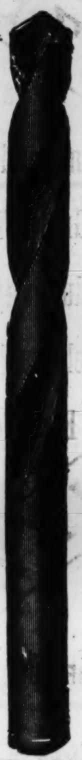

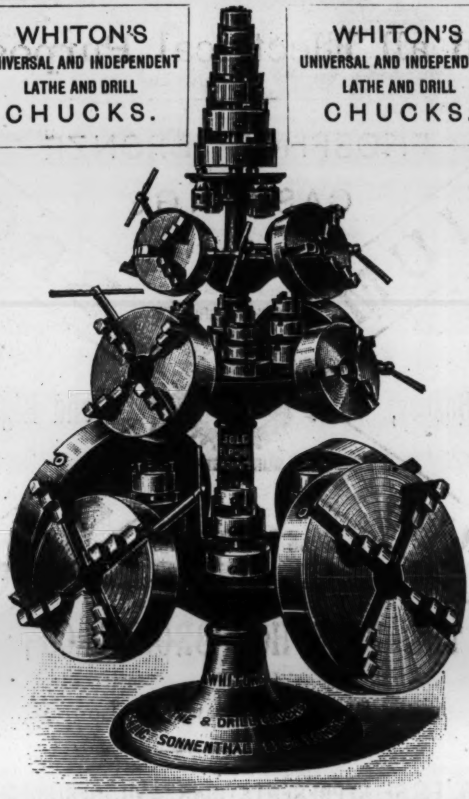

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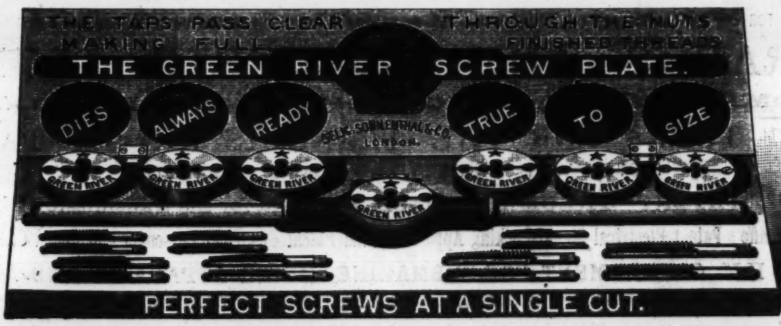
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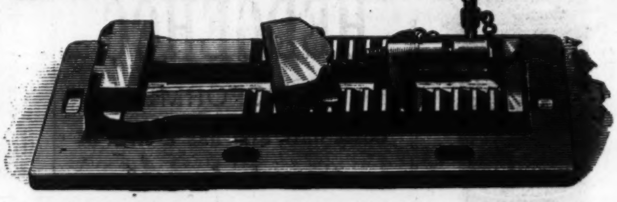

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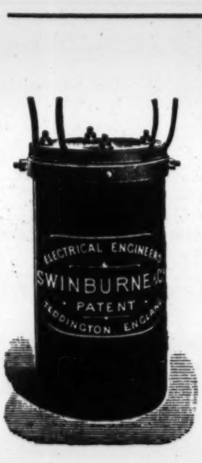

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12	...	4	4	0	300	12	30	0	0
25	1	5	10	0	400	16	35	0	0
50	2	8	18	0	500	20	40	0	0
100	4	12	15	0	750	30	55	0	0
150	6	17	17	0	1000	40	70	0	0

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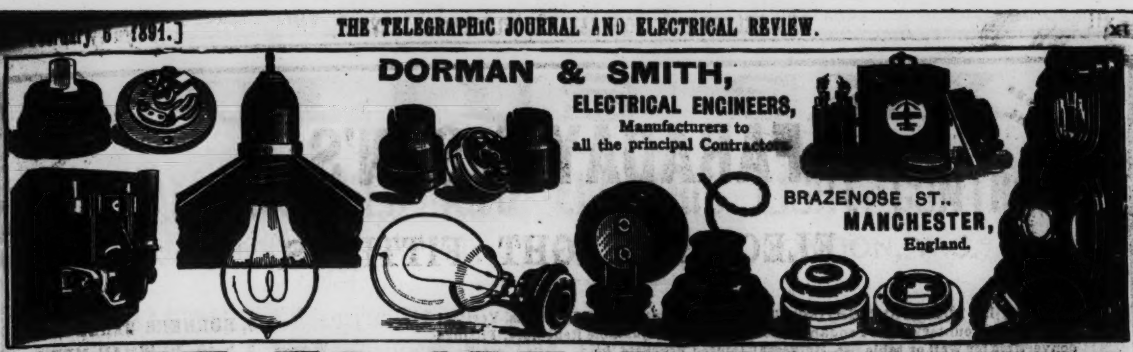
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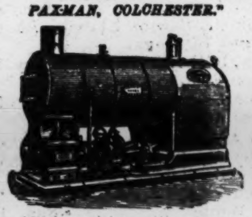

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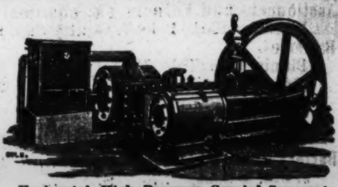

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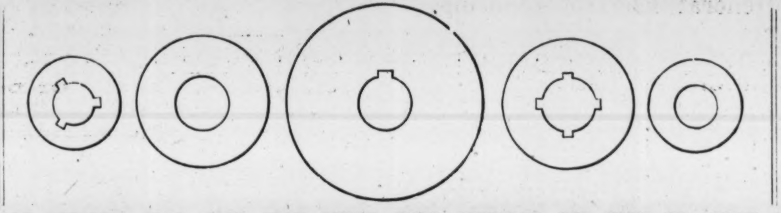

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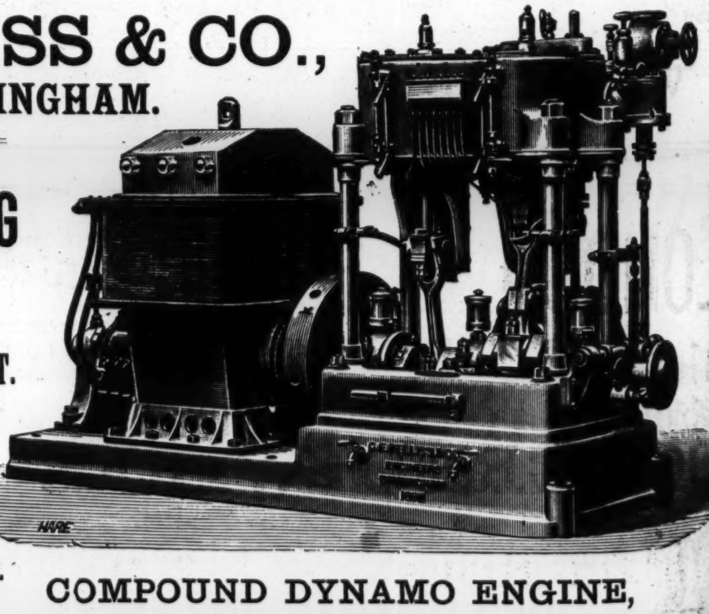

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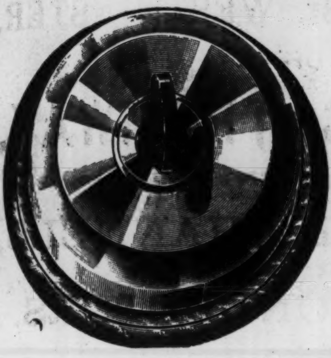

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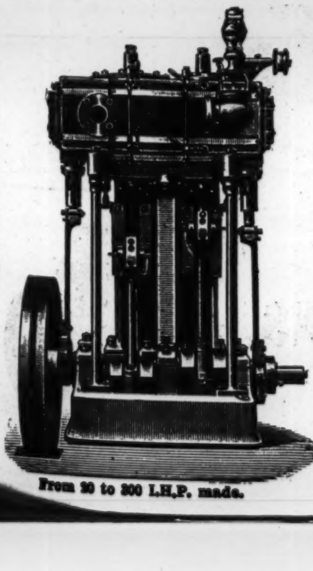

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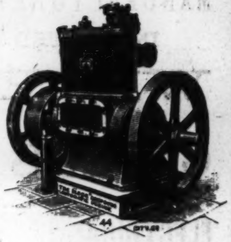

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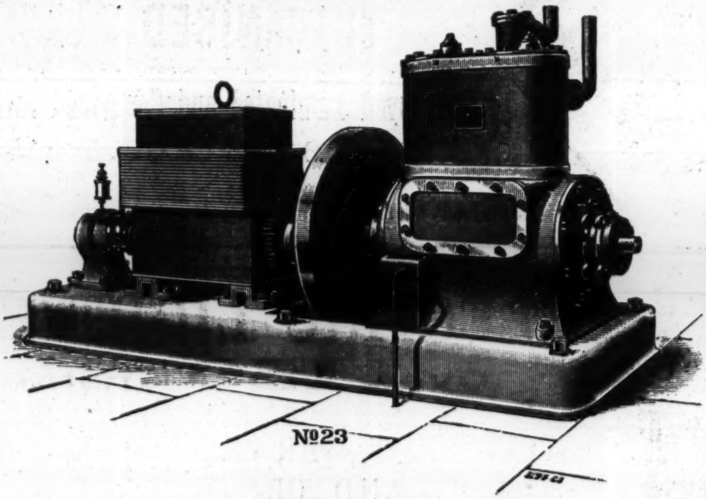

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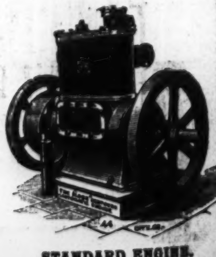

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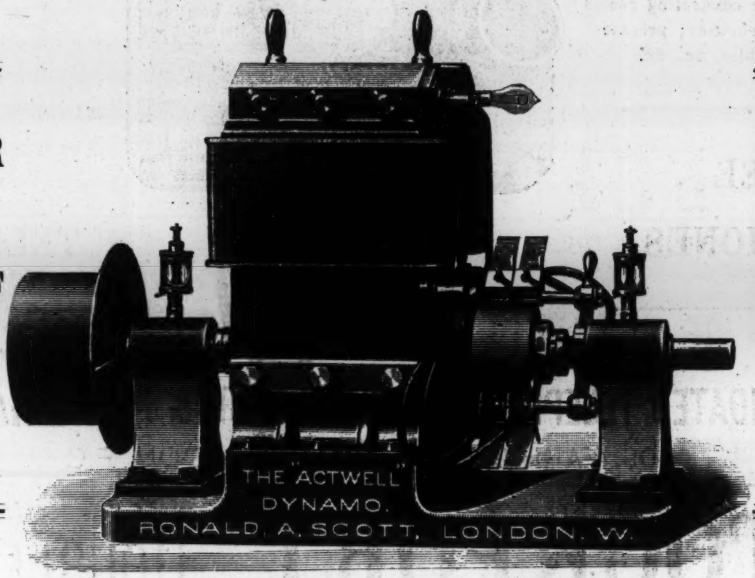
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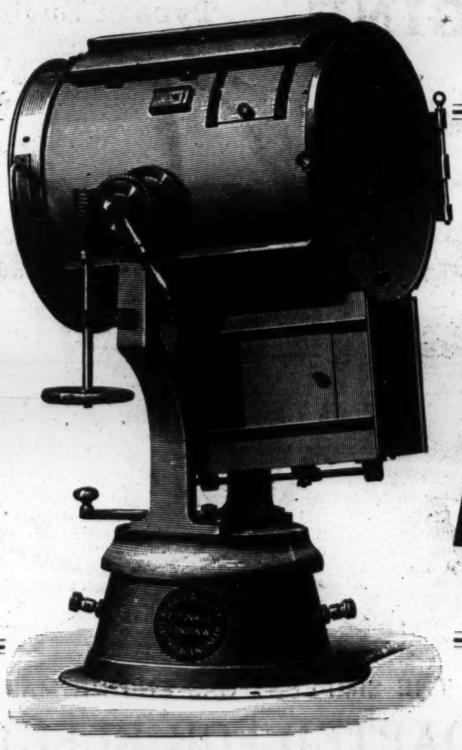

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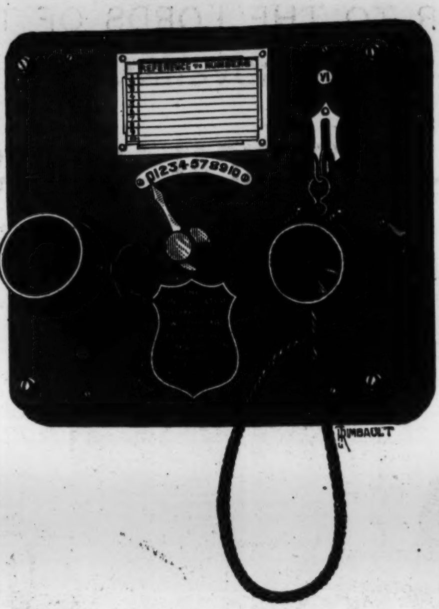

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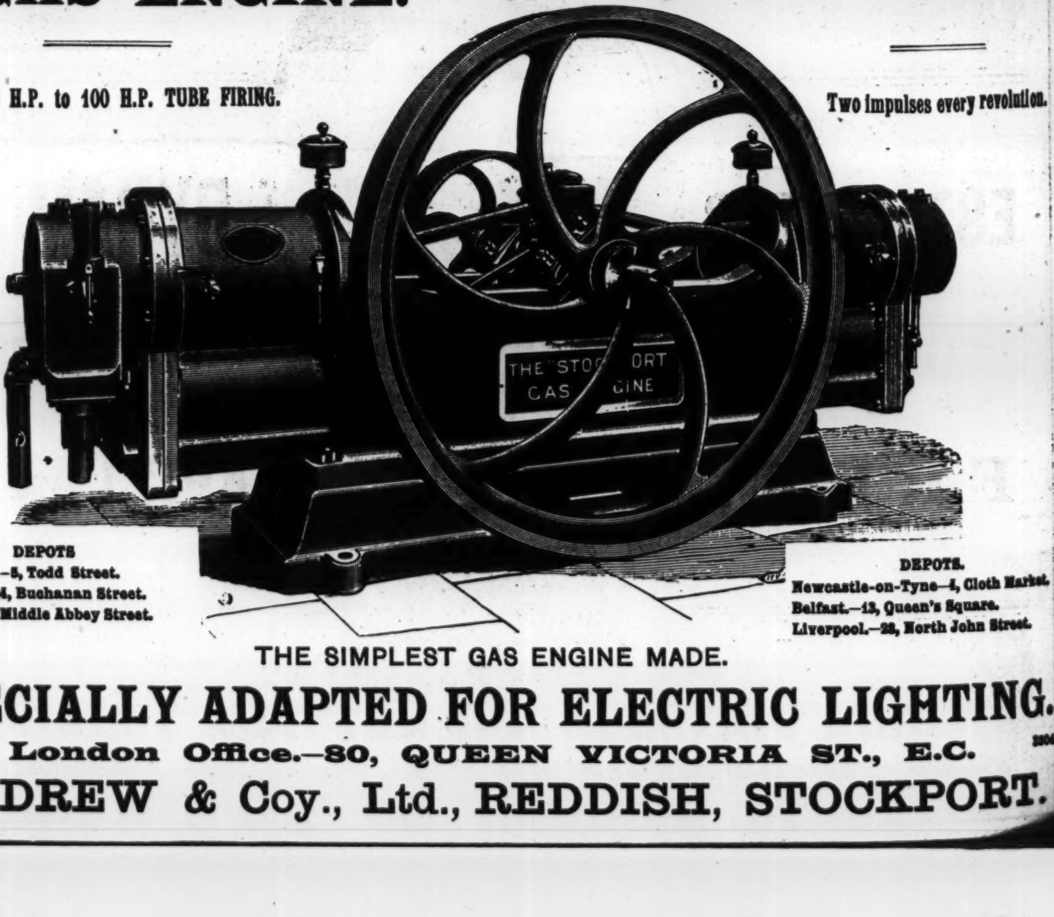

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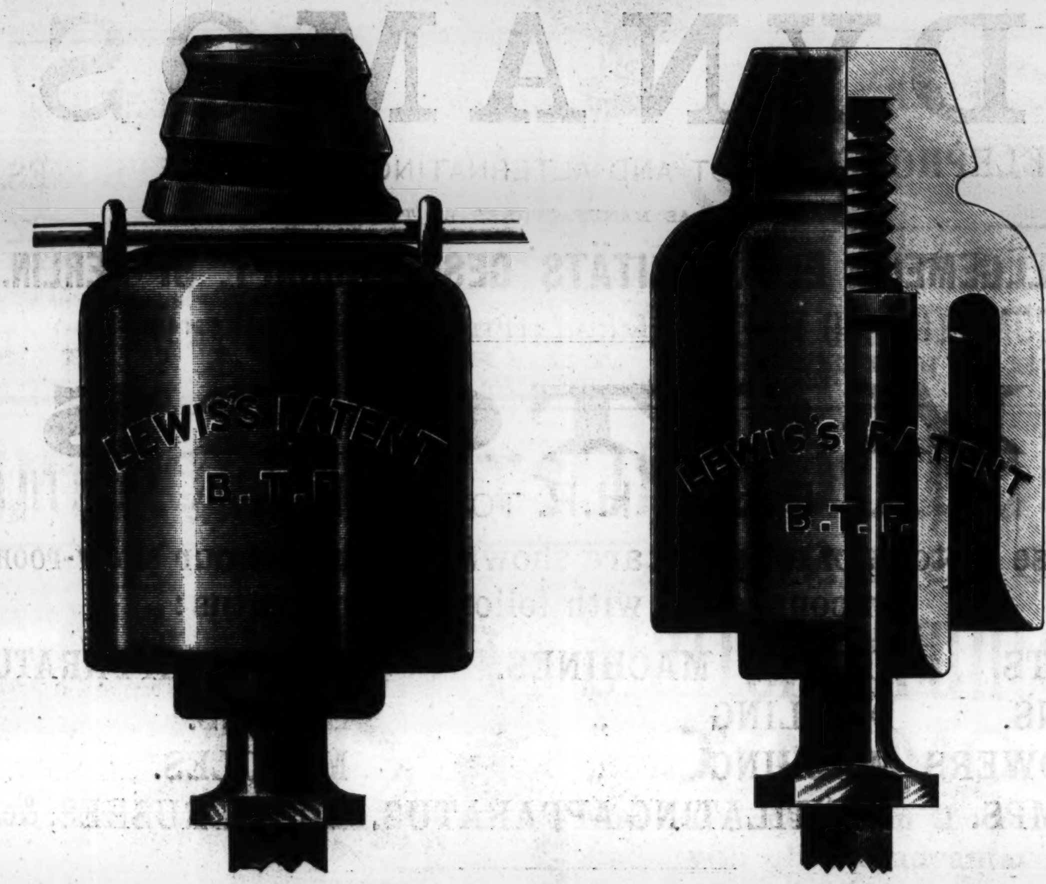

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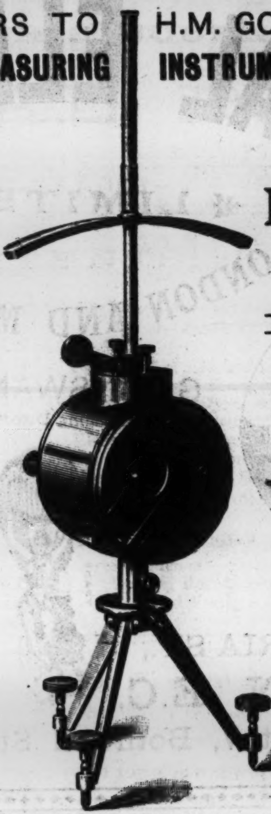

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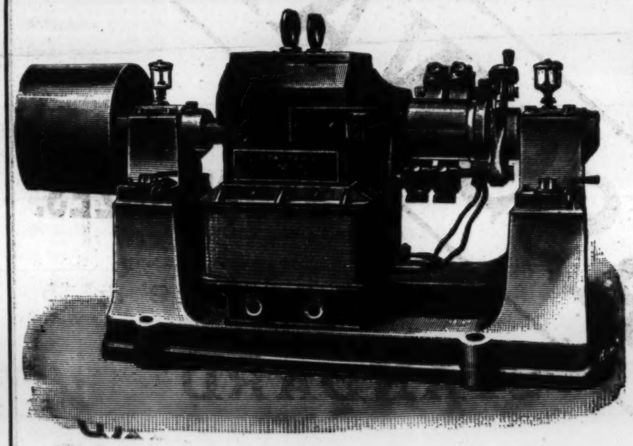

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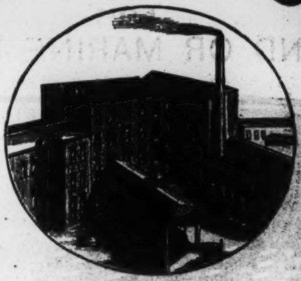

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VOL. XXVIII. FEBRUARY 6, 1891. No. 689

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THE ELECTRIC TRAMCAR SYNDICATE, LIMITED.

THIS syndicate, which has a nominal capital of £20,000 in 700 preference shares and 1,300 ordinary £10 shares, is issuing 200 preference shares of £10 each, entitled to a preferential dividend of 7 per cent. per annum, and to a distribution *pro rata* of the surplus profits after 7 per cent. per annum has been paid on the ordinary shares. This issue becomes necessary, in order to provide for the expenditure to be incurred for electric charging stations, plant, &c., so soon as negotiations, initiated for running this company's cars, result in a contract being entered into with a tramway company, and to commence the electric lighting from the company's depôt, there being already signatures for 300 lights. The company has now two electric cars completely fitted, and a third nearly completed.

The amount of cash about to be raised is not excessive, and it is required by the syndicate exploiting Jarman's system of electric traction, one already so well known to our readers, that we need not enter into any particulars regarding its motors or gearing, which we know will work. The directors are confident that the company has, in the Jarman patents, the most efficient and reliable system of electric traction extant, and it is just the reasons which lead them to this belief that we would like to learn. Mr. Jarman has been plodding along cautiously and patiently for some years, and he must have gained much valuable experience; but as he depends upon accumulators for his supply of motive power, it seems to us that his directors are not acquainted with the results which other traction companies have experienced who pinned their faith on secondary batteries. We do not say that Mr. Jarman must necessarily be wrecked on the rock upon which others have struck and foundered, but we do think that the members of the syndicate should be alive to the possibilities of such a disaster.

We have all along hoped to see Mr. Jarman succeed in doing legitimate work, but we do not quite like the tone of the following paragraph in the directors' appeal for more funds. "Independently of any profit which may be derived from the partial working of a tram line, the opportunity of thoroughly demonstrating the merits of the company's system is of far greater importance, and is indeed essential to the end for which the syndicate was formed, viz., to prove the commercial value of the Jarman system, and then to secure for the subscribers to the present company the large profits to be realised by the sale of foreign patents, and the conversion of the present undertaking into one of more important dimensions."

Now we feel pretty certain that unless Mr. Jarman has hit upon an accumulator very much superior to those which have hitherto been so quickly used up in electrical tramcar service, the syndicate has its work cut out to prove the commercial value of the system, and unless this can be done we fail to see but a very remote chance of disposing of foreign patents.

We were under the impression that Mr. Jarman's system had advanced beyond the realms of mere projects, and that contracts had already been made with a South London Tramway Company, but it seems that the affair may resolve itself principally into a patent vending company. Provided the proofs are forthcoming for which the syndicate was formed, we see no objection to this course, if purchasers can be found; but we fancy the days are over for disposing of untried methods of electric traction. Let Mr. Jarman but succeed in showing that he can successfully compete with horse traction for a period of, say, twelve months, which is quite necessary to test the lasting powers of the batteries, and his supporters will find plenty of employment.

THE CITY ELECTRIC LIGHTING.

WE cordially participate in the pleasure which Mr. Preece on Tuesday expressed himself as feeling at finding that the City of London was on the eve of a general scheme for the electric lighting of the streets, and it can now no longer be said that the City is a laggard in adopting a very necessary improvement. Still, the time spent in bringing about this long-looked-for consummation has been spun out to an inordinate length, and aptly illustrates how time flies, for scarcely anyone, even those who have followed the various proposals for the City lighting, will credit that negotiations have been on foot during the greater part of a decade, yet they commenced about eight years ago. The result now finally reached is the division of the City into three sections, the details of which we publish elsewhere.

Mr. Deputy Green, in asking the Lord Mayor to inaugurate the first step towards the lighting of the City by electricity, remarked that he ventured to feel that they were now within measurable distance of finding the City of London the best lighted city in the world, as it was now the best scavengered. He also called attention to the following comments in last Saturday's *City Press*, which run as follows:—"We may, therefore, hope that during the hours of business the City will even under such fogs such as we have recently suffered—be a bright and thoroughly well illuminated place to walk in. The improvements it will bring in our warehouses and offices it is impossible to overrate, when the mains are down for street lighting the private work can be advantageously undertaken at a price comparatively little in excess of that of gas; but the Commissioners have fixed a rate which is equitable to all parties. Under these circumstances, in participating in the ceremony of Tuesday next, the Lord Mayor will probably be inaugurating a practical revolution in the conditions of City life. Health, comfort, and convenience will be served, and we can only hope that electric lighting in the City will fulfil all the hopes at present entertained on its behalf."

The wish of the *City Press* will find a ready response in the feelings of all who desire to see electric lighting become more universal, and although we may look for mishaps at the beginning, all will come right in the end. We feel to a certain extent gratified that we published in our issue of January 16th what was perhaps the most exhaustive description of an arc-light central station yet written. It was entitled "The Largest Arc-Lighting Station in the World," and we are sure that both the contracting companies, whatever may be their knowledge or views of the arduous work before them, cannot but derive such practical information from this paper, as will prove of inestimable advantage. To such a state of perfection, indeed, has the station to which we allude been brought, that failure, even in a minor degree, seems altogether out of the question.

Let us hope that the Brush Electrical Engineering Company, and the Laing, Wharton & Down Construction Syndicate may not be above taking a lesson from American practice, and the chances will be all in their favour; they deserve success, and it mainly rests with them to obtain it.

THE PUBLIC PRESS AND ELECTRICITY.

WHILST there are many sub-divisions, it is safe to classify the press into two parts—the general and the technical. The power of the press, and the benefits it confers upon the public, are generally recognised; we might say universally admitted, except for the few who regard printing as a black art in a double sense, and printers "devils" as of very real existence.

The members of the "Fourth Estate" consider the "power" of the press to apply to the newspaper press, and the public understands the newspaper press to mean those numerous and marvellous broad sheets issued daily in London or the provinces, each having the largest circulation in the big or little world to which it appeals. To it the public turns on all subjects for information and enlightenment, for guidance or advice, and seldom turns in vain; because whether in politics or law, in money or in music, the press recognises that this is the age of specialists, and, as a rule, takes care that any information it may impart, or any views it may express, are from the specialist's hand. In science, too, if it be but abstract science, the specialist may be seen. Only in the practical applications of science or new industrial developments does the press act upon the principle which was once expressed as an Editorial rule—that the description of a new machine, or information on a new industry, must be communicated by one entirely ignorant of the subject, because he alone can convey the information in a manner suited to readers who must also be presumed to be ignorant of the subject.

Though this was doubtless spoken in a sarcastic vein, it is unfortunately in a large majority of cases the actual method adopted. The result is that the journalist in search of copy, having to describe something wonderful, makes it more wonderful; unaccustomed to see "wheels go round," the simplest mechanical operation becomes a marvel, and is so described. Or, if the reporter does not draw on his imagination, he records with fidelity all that he is told. In this way the public receives information of a most misleading character. In this way a J. B. Rogers becomes a great inventor, and a "compound binding screw" went forth to the world as an electrical cistern, which, of course, "solved a problem." In this way the arrant twaddle of a Harness receives as much attention as the weighed and measured utterances of a Siemens. There is no sense of proportion whatever.

The past decade has seen the *renaissance* of electricity in its industrial aspect. The present decade will see its vigorous growth. But the extent of the growth, and the nature of it, will largely depend upon the attitude of the general Press.

If we have to draw attention to short-comings, to indicate a possible improvement, or perhaps apportion some blame, we must not overlook the fact that electricians are largely indebted to the general Press for popularising industrial electricity, and the dissemination of information tending to advance it in all its branches. What we desire to point out is that with the good has also been done some harm, both to electricians and the public, and from the past we desire to draw a lesson for the future.

Let us regard the matter for the moment from an investing point of view. During the past ten years large sums of money have been lost in electrical ventures. In some few cases the losses of individuals have been a gain to the community, or a gain to science. In some other cases the loss, though unfortunate, could not have been foreseen, and the risks were reasonably incurred. But in several instances money has been simply wasted or thrown away, without any element of satisfaction to science, community, or individual, except, perhaps, the promoter, the unprincipled adventurer, or the over-sanguine inventor. We have no hesitation in saying that much responsibility for this lies with the general Press. Examination of our files for the period under review reveals warning after warning in regard to unsound electrical schemes submitted to the public for support. In some, the merest tyro in electrical knowledge would have seen the utterly impossible. In others, the slightest discretion, tempered with knowledge, would have seen the unwise. Yet the general Press have set forth these schemes as practical and desirable. Their responsibility is not so much active as passive. It arises from the mistaken policy which permits a general journalist to deal with technical subjects.

Let us consider the method usually adopted to obtain publicity. The Press is invited to inspect some new machine or some new process. A dinner is included in the inspection, and the information is imparted in after-dinner speeches or thoughtfully-prepared leaflets. If the *locale* is distant, a Pullman, with a restaurant car attached, is an essential. A much condemned playwright once complained that favourable criticism was assisted by chicken and champagne. We know pressmen too well to endorse the suggestion that the good fare has anything to do with the "good" reports. A representative may do his work to the best of his ability and with a due regard to his responsibility, but he cannot criticise that of which he knows nothing; he cannot sift the wheat from the "chaff" when he knows not the one from the other. Consequently, all that an interested person desires to be communicated to the public is communicated to the public. Whilst we have been issuing our warnings, the general press has been placing the public in possession of the promoter's, the adventurer's, or the sanguine inventor's views *in extenso*, the public assume the claims to be correct, and find, only after many days, that their confidence has been misplaced. It is due to the public, to the press, and to the electrical profession that this should cease. It would go some way towards ceasing if the press—and especially the daily and financial press—would realise that electricity is a subject of daily increasing importance—of such importance, in fact, as to justify its being handled in their columns by one having the knowledge and discretion which will enable their readers to receive information which is reliable and correct, and whilst knowing what to insert knowing also what to omit.

The Extraction of Metal from Refractory Ores.

IT has long been said that electricity cannot compete with the ordinary processes for extracting gold and silver from their ores. In a letter to *Industries*, however, Mr. E. Andreoli states that as long as gold and silver are not dissolved and separated *in one single operation* the problem of the extraction of the precious metals will not be solved, but that to exhaust the ore and to deposit the gold and silver it contains there is nothing like an electrolytic process. Many patents have been taken out for processes by which the precious metal is extracted by the solvent power of cyanide of potassium, but recently Messrs. MacArthur and Forrest claimed to have discovered afresh this solvent power, which Mr. Andreoli points out has long been known, and it is difficult therefore to see in what the so called discovery consists. Again, it is somewhat remarkable that simultaneously with the publication of Messrs. MacArthur and Forrest's specification another patent for amalgamating ores by Professor W. Crookes, should appear, in which it is stated that cyanide of potassium has very little solvent action on gold. As regards the electrical process for extraction, Mr. Andreoli informs us that the highest price of an installation for the treatment, without wasting, per 24 hours, of 40 tons of refractory auriferous and argentiferous ores, would not be £700, all included — f.o.b., engine, dynamo, tanks, electrodes, &c.; and that, according to the circumstances and especially to the quality, rebelliousness, and richness of the ores, the extraction of more than 90 per cent. of the gold and silver they contain would cost generally from 5s. to 10s. and 15s. per ton, and at the maximum £1 for the very refractory pyrites, &c. There is not a single process which can allow the separation of gold and silver, and in 10 or 20 tanks as the electric current does.

Central London Railway and the Purchase Clauses.

THE London County Council, at its meeting on Tuesday last, discussed, without arriving at any decision, the Parliamentary Committee's recommendation, "that the Council's petition against the Central London Railway Bill do contain a provision asking that clauses for the ultimate purchase of the undertaking by the local authority similar to those at present contained in the Tramway or other Acts, may be inserted in the Bill." At first sight it would seem that as in the case of tramway and electric light companies in which the principle of the purchase clauses (after much consideration) obtains, there is no reason why the same clause should not hold good, but it may be pointed out that the cases are not analogous. In the case of tramways running on the road level, it would be intolerable that a badly managed system should be allowed to interfere with the ordinary traffic, and it is quite conceivable that the local authority would have to use the clause solely to protect the community. Similar arguments would, to some extent apply in the case of electric light companies and in both instances practically monopolies are granted which might become injurious to the public interest. In the case of underground railways we do not think the reasons for the clause hold to the same extent. There, once the line is constructed and proper precautions taken to avoid annoyance to others by vibration or otherwise, the electric railway might go on its way indefinitely or stop entirely and no other traffic need be interfered with. The only reason we can at the moment see for the introduction of a purchase clause is to prevent the possible occupation of the ground by a company subsequently misusing its privileges or abandoning the working altogether. It is also obvious that the electric railway is more analogous to the older steam railway for which no such clause, we believe, is ever inserted.

The City and South London Railway Company.

AT the special meeting of this company held on Tuesday last, some figures were given by the chairman which are very interesting, and which seem to bear out the contention of Mr. Willbond in his article published on January 2nd in the REVIEW in so far as the number of passengers to be obtained is concerned. 11,000 trains and 1,000,000 passengers in six weeks, with 15,000 passengers a day now being carried, point to the fact that the numbers have rapidly fallen off, and at the present time are rather under an average of 50 passengers per train, while at the start more than double that number were probably carried. The falling off may, and probably, will, be continued somewhat further for a few weeks, but the traffic of the next three months will be most likely very close to that which will usually be conveyed, and it appears to us now, as it did when our editorial note was appended to the article of the 2nd ultimo, that the expenses will be very much lighter than the writer of that article assumed, and the possibility of profit so much the greater.

ON THE ALTERNATING ELECTRIC ARC BETWEEN A BALL AND POINT.

By EDWARD L. NICHOLS.*

PART 1.—*From Experiments made by Messrs. W. K. Archbold and G. L. Teeple.*

THE phenomenon which forms the subject of this paper was first brought to my notice by Mr. E. G. Acheson, the result of whose unpublished observation may be briefly stated as follows :—

Two wires which formed the terminals of the secondary coil of an alternating current transformer were brought nearly into contact. One wire was armed with a ball, the other with a point. When the distance was such as to admit of a discharge between the two, it was found that a galvanometer in shunt around the ball and point indicated a considerable flow of continuous current.

This phenomenon has recently been subjected to investigation by Messrs. Archbold and Teeple. Their experiments, from which in great measure the data used in the first part of this paper have been taken, are described at length in their "Thesis in Electrical Engineering," which is now in the library of Cornell University.†

The apparatus used in the verification of Mr. Acheson's observation consisted of a Ruhmkorff coil of moderate size, the interrupter and condenser of which had been thrown out of circuit. The primary coil, as in all instruments of that type, consisted of a few turns of heavy wire surrounding a core of iron wires. When this coil was supplied with current from a small alternating current dynamo making 14,000 reversals a minute, and the terminals of the secondary coil were brought into position, a discharge of considerable brilliancy took place between them. To the unaided eye, the discharge appeared to be perfectly continuous, but the fact that it was really of an intermittent and periodic character, was indicated by the emission of a well-defined musical note, which corresponded in frequency with the period of alternation of the dynamo.

The terminals of the secondary coil were subsequently connected with a brass ball, about one centimetre in diameter, and with a point consisting of a steel sewing needle. These were mounted horizontally in well insulated bearings, the centre of the ball in line with the axis of the needle. The distance between the ball and the point of the needle was capable of adjustment by means of a micrometer screw. A mirror galvanometer of 2,000 ohms, having in its outer circuit about 100,000 ohms, was shunted around the ball and point (in parallel circuit with the air space between them). When the induction coil was put into operation, the ball and point being too far apart to admit of a visible discharge, the galvanometer needle remained at zero, but when they were brought within striking distance, a large and constant deflection was produced. When the ball and point were interchanged, the deflection was reversed, its direction always being that which would have resulted from a current flowing from the ball to the point. Under the influence of the discharge, which was intensely luminous, the steel needle was fused at the point and rapidly wasted by oxidation, so that it became necessary to find some more refractory material.‡ It was finally supplanted by a pointed platinum wire which, although rendered highly incandescent, withstood the temperature of the arc much better than steel had done.

The following quotation will serve to indicate the conclusions reached by the observers in the course of their preliminary experiments with the platinum point :—

"The behaviour of the arc, as its length is increased, is very curious. As the point is withdrawn the arc forms and sings with an even tone, the pitch corresponding to the number of alternations. The point becomes of a dull red colour while the galvanometer gives a small but quite steady deflection. As the arc is drawn out it sings louder and more harshly, the point becomes redder, while the galvanometer deflection increases and becomes very unsteady. At a certain critical length the following phenomena suddenly occur: The tone becomes smooth and even, the point brightens almost to a white heat, the intensity depending upon the strength of the current, while the galvanometer deflection becomes much greater and very steady. The explanation suggested, and which subsequent experiments seem to confirm, is as follows : At first the arc forms both ways, the rapid succession giving the tone. As the arc lengthens the arc still forms from ball to point, but is only intermittent (occasional) from point to ball, giving the unsteady tone and deflection. Finally, the distance becomes too great for the arc to form from the point to the ball, while it still passes freely the other way, and the tone and deflection become steady." *

The main portion of the investigation consisted in the determination of the periodic changes of electromotive force and current during a complete cycle, when no arc existed, and of the modifications introduced into the curves of potential and current by the discharge between ball and point. Throughout the entire series of measurements the striking distance was greater than the critical value already defined, a condition the maintenance of which was secured by watching the indications of the galvanometer.

The instrument used in the measurement of electromotive force was a Thomson mirror galvanometer of 10,000 ohms resistance. The galvanometer line was carried to the dynamo, where, by means of an instantaneous contact device, the circuit was closed during an interval of exceedingly short duration, once in every revolution. The device consisted of a wooden disc, mounted upon the shaft of the machine. A single bar of brass, on the periphery of the disc, passed under a brush at every turn. This bar was connected metallically with a brass collar on the shaft, and a second brush, bearing upon the collar, completed the circuit. By thus closing the line through the galvanometer, for an instant, once in a revolution, the electromotive force of the secondary circuit, at that particular point of the cycle for which the contacts were made, could be measured ; and since the brush was adjustable through considerable range, the entire cycle could be explored.

FIG. 1.

The arrangement of the entire apparatus is shown in fig. 1. P, C, and S, C, are the primary and secondary coils of the inductorium, *p* and *b*, respectively. the point and ball. R is a non-inductive resistance, *g* the indicating galvanometer, in parallel with the ball and point, *r* a non-inductive resistance, *s* a switch by means of which the Thomson galvanometer could be shunted at will around R or *g*. K is the instantaneous contact device, and G is the Thomson galvanometer. When the Thomson galvanometer was shunted around R, which was placed in the main circuit leading from the induction coil, it served to indicate the current flowing in that circuit during that portion of the cycle for which contact was being made; when connected in shunt with the galvanometer, *g*, it measured the fall of potential through the coils of the latter instrument. The function of the indicating galvanometer, during this part of the investigation, consisted in showing, by the size and direction of its deflection, whether the discharge between the ball and point continued to maintain its proper character.

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* *Electrical Review*, New York.

† "The Effect of Placing a Ball and Point in a High Potential Alternating Current Circuit," by W. K. Archbold and G. L. Teeple. Thesis in MS., Cornell University Library; 1889.

‡ The attempt to use carbon terminals led to the following observation :—"A carbon pencil substituted for the point gave the same effect, but upon putting the carbon in place of the ball, it still acted as a 'point.' If two carbons were used the more pointed one acted as a 'point.' It was observed that the end of the needle was fused into a ball by the heat of the arc, and would then act as a 'ball' to the smaller particles of carbon projecting from the end of the pencil. Two brass balls brought together caused a drifting of the galvanometer needle from one side to the other, according, it is to be presumed, as the discharge changed the nature of the two surfaces, so that minute points formed on one or the other." (Archbold and Teeple ; Thesis, p. 3.)

* Archbold and Teeple ; Thesis, p. 5.

The result of measurements throughout a complete cycle, both when the arc was formed and when it was extinguished, is shown in curves B and A (fig. 2). Curve A is with close

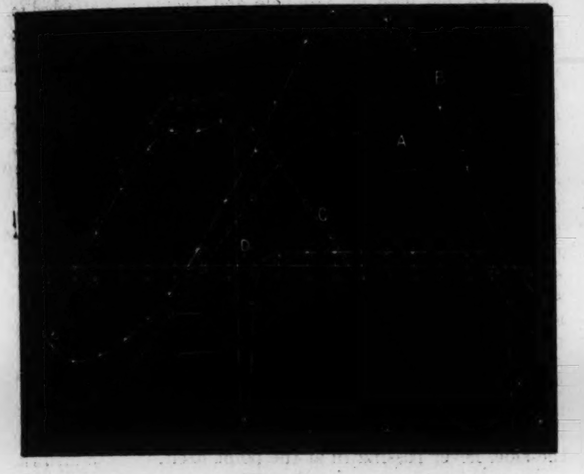

FIG. 2.

approximation a curve of sines, and it indicates the usual fluctuations of current to be looked for in the secondary circuit of an alternating system. Curve B shows the current throughout the cycle when the arc was playing. Abscissæ represent portions of a complete cycle, the period being divided into 20 equal parts, ordinates the relative amounts of current through the resistance, R, or the total current in the secondary circuit. Deflections, when the current flows from ball to point, are plotted above the base line. As may be seen from the curve, B, the current flowing in the positive direction during each cycle was greatly in excess of that flowing in the negative direction, when the discharge was taking place between ball and point, whereas when no arc was formed (curve A), the areas enclosed by the positive and negative branches of the curve were equal. Now, there were two paths offered to the current, that through the galvanometer, *g*, and the resistance, *r*, which consisted of a column of copper-sulphate solution between copper poles (approximately 112,000 ohms) on the one hand, and the parallel circuit between the ball and point on the other. The resistance of the latter path was infinite whenever the arc was interrupted, falling to finite values during each discharge. Increase of current through R indicates, therefore, the formation of the arc. Such increase is found to exist during the second half of each cycle, that is to say, during that interval in which the ball is positive; and it might be inferred from these curves alone that the discharge was an intermittent one taking place always from ball to point. Other curves, taken simultaneously with A and B, the Thomson galvanometer being shunted around the indicator galvanometer, lead to the same conclusion. The curves marked C and D (fig. 2) show the results obtained. It was thought that they would give the fluctuations in electromotive force between ball and point, corresponding in time to the current fluctuations in the resistance, R. The indicating galvanometer, however, owing to the very rapid alternations to which the circuit was subjected, was found to possess such high self-induction as to materially influence the result. Strictly speaking, the curves C and D, therefore, give the periodic changes of electromotive force at the terminals of the indicator, and not those occurring at the ball and point.

These curves are nevertheless of considerable interest. The curve, C, shows the character of the cycle when no arc was formed, and D, when the arc was in operation; C, like A, is approximately a curve of sines. The irregularity at its positive crest, which also appears in D, is probably due to the imperfect performance of the contact brush, and having no bearing upon the phenomena which the curves are intended to elucidate, may be disregarded. Since no current was passing between the ball and point when A and C were taken, they represent the fluctuations in successive portions of the same circuit. The lag, due to self-induction, however, is very marked, amounting to almost 90° of phase. Curve, D, which shows the influence of the arc, is especially instructive. The potential rises during the first part of the cycle (ball positive); then follows a very sharp oscillation, occupying about $\frac{1}{20}$th of the entire period, or $\frac{1}{4600}$th of a second of time. The potential then reaches a small positive value, which it maintains without fluctuation for at least four-tenths of a complete cycle, when it suddenly becomes strongly negative.

To obtain curves of electromotive force between ball and point directly, a non-inductive resistance was substituted for the indicating galvanometer and the measurements from which curves, C and D, had been drawn were repeated. Of the two curves thus determined, the one taken when the arc was not playing (E, fig. 3) is a sine curve closely coinciding in phase with the simultaneous curve of current (A, fig. 2). The corresponding curve, F, which was taken while the discharge was passing between the ball and point, is in its essential features of same character as curve, D (fig. 2). The interval of uniform positive potential is of the same length, and it is coincident with the interval of excess of current which shows itself in the positive branch of curve, B. It is noteworthy that this interval of uniform potential, which marks the duration of the arc, occupies in both cases the same portion of the cycle (between scale-divisions 10 and 19, approximately), although there is otherwise a difference of phase, due to self-induction, amounting to at least four scale-divisions. Curve, C, for instance, reaches its maximum in the neighbourhood of scale-division 8, curve, F, at scale-division 12. The exclusion of the coils of the indicating galvanometer from the circuit reduced this difference of phase to a small quantity, and it suppressed altogether the remarkable oscillation of electromotive force (see curve D) which in all preceding experiments had introduced the formation of the arc.

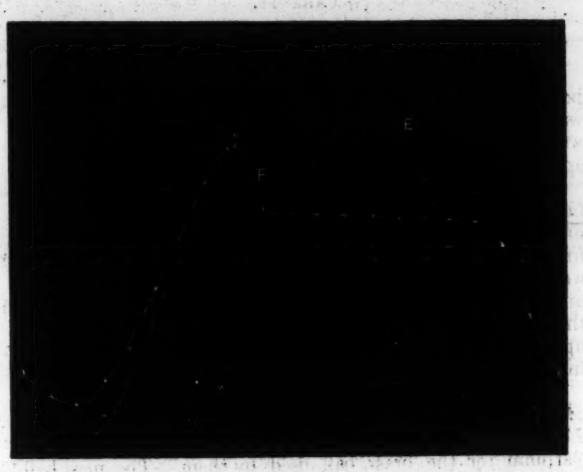

FIG. 3.

The results exhibited graphically in these six curves afford abundant verification of the theory of the ball and point phenomenon given in a previous paragraph; and they establish the fact that in the secondary circuit of a transformer, such as that made use of in these experiments, the striking distance from ball to point exceeds that from point to ball. It follows that whenever the space between the ball and point is less than the former and greater than the latter distance, discharge will occur only during that portion of each alternation for which the ball is positive, and that under such circumstances a galvanometer placed in the circuit will show a constant deflection.

Complete corroboration of the foregoing conclusion was obtained by studying the image of the arc in a revolving mirror. With a discharge of less than the critical length, the discharge was seen to consist of two distinct sets of sparks, all of the same duration but differing in colour. Each alternate discharge was purple, the intermediate ones being of a greenish cast. The spark images were everywhere equidistant, and their duration was about four times as great as the intervening intervals of darkness. The extension of the sparking distance beyond the critical point resulted in the complete suppression of the series of purple images, the intermediate ones remaining undisturbed in position, duration, and appearance. The intervals of darkness were then estimated to occupy six-tenths of each cycle, the discharges, four-tenths; a ratio which corresponds with that of the duration of positive potential of the ball (as shown in curve) to the total length of a complete cycle.

The ball and point phenomenon is unquestionably very closely related to a class of effects with which students of static electricity have long been acquainted. One recalls, to begin with, Faraday's experiments with the Leyden jar, in which, of two paths, the spark invariably followed that involving passage from a positive ball to a negative point, in preference to another, through equal air-space, between a negative ball and a positive point.* Wiedemann and Rühlmann have since shown that between spherical electrodes which differ in diameter, the quantity of electricity necessary to produce a discharge is less when the larger ball is positive than when it is of negative charge,† and Macfarlane has measured the electromotive force which will produce a spark between a point and plate, and has found it to be greater when the point is positive than when it is negative ‡

In view of the experiments described in the present paper, it appears that what is true, in this particular, of the spark from the Leyden jar, and the discharge of the Holtz machine, is true also of the alternating current arc.

PART II.

From Experiments made by Mr. F. C. Caldwell.

After the completion of the experiments of Messrs. Archbold and Teeple, the study of the ball and point phenomenon was taken up under the writer's direction by Mr. F. C. Caldwell; the chief purpose of the investigation being to test the applicability of the effect to alternate current measurement.§

Irregularities of action, due to rapid changes in the surfaces of the point and ball, by corrosion and disintegration under the arc, finally caused the attempt to be abandoned for the time being, but Mr. Caldwell, in the course of his work, made a large number of observations of the discharge under various conditions. Many of these are of interest in this connection, on account of the light which they throw upon the original experiments, and because of the lines of further research which they suggest.

Mr. Caldwell's first step, after having repeated the preliminary experiments of Archbold and Teeple, and verified their statements, was to substitute a ball with a surface of platinum for the brass ball used by them. The new ball withstood the action of the arc no better than the old one had done. It soon became covered with a black deposit, the growth of which modified and vitiated the action of the apparatus. In experimenting with such a ball, the surface of which was still bright and new, and with a point of the same metal, it was noticed that within the critical distance, while the spark was passing in both directions, there appeared to be two distinct paths along which the discharge was taking place. One of these was nearly in the line from the point to the ball, normal to the surface of the latter, the other from the point in a direction approximately at 45° with the common axis of the pointed rod and ball. Upon increasing the distance until the discharge entered the "one way" stage, the longer and oblique path of flow vanished. In the revolving mirror the two classes of sparks were easily identified. They were found to occur in alternation with each other, the spark which followed the normal path being that which passed from ball to point, the other that from point to ball. The images of the discharge from the point disappeared as soon as the critical distance was reached. In order to place the matter beyond all doubt, the times of the discharge which followed the normal path were determined by an ingenious method, quite independent of that used by the first observers, and it was found that the spark occurred always in that part of the cycle during which the ball was positive.

Mr. Caldwell's method of fixing the time of the discharge, briefly stated, was as follows: An adjustable contact device, similar to that used by Archbold and Teeple, was attached to the shaft of the dynamo. A wire from one pole of a large Holtz machine, driven by power, was carried to the neighbourhood of the ball and point, where two platinum terminals, 1 mm. apart were set up. The wire was connected with one of these, and a line was carried from the other to the contact device. A wire from the latter to the remaining terminal of the Holtz machine completed the circuit. Whenever the brush made contact, a spark leaped between the platinum terminals just described. By adjustment of the brush, the spark could be made to appear at any desired instant in the cycle of alternations of the dynamo. The platinum terminals were placed so that the image of the spark in the revolving mirror was seen side by side with that of the discharge between the ball and point, and the precise position in the cycle, occupied by the latter, was thus readily determined.

Closer study of the two paths of discharge showed that the oblique arc left the very apex of the point, swinging out laterally into its path; also that the normal arc, on approaching the point, avoided the apex, and entered the wire from the side, never passing in at the point itself.

From these observations it appears:

1. That the discharge from the ball (positive) leaves the latter in a direction normal to the surface, but that it enters the other terminal at some distance from the apex.

2. That the discharge from the point (positive) leaves the very apex of the latter, but is deflected into a course nearly 45 degrees from the axis, and reaches the ball obliquely at some point on its side.

Taking these observations into consideration, the explanation of the cessation of the discharge from the point at the critical distance and of the establishment of the "one-way" arc, follows at once. The two paths of discharge differ in length, and for a given electromotive force the maximum striking distance is sooner reached in the case of the oblique than of the normal arc, so that the latter continues to pass at greater distances (of ball and point) than the former.

Further inspection of the images of the two arcs in the revolving mirror revealed another curious fact. The mirror was set up with its axis of revolution parallel to the common axis of the ball and point. The image of an instantaneous spark following the line of the normal arc would, therefore, be a line parallel to the axis of the mirror. Since the duration of the discharge was nearly ·001 seconds, this linear image was expanded into a broad rectangular band. The image of any oblique discharge would in general be an oblique parallelogram. The image of the discharge from point to ball, however, was not of that form. It appeared rather as a warped surface, the form of which could be explained only by supposing that the discharge at first followed the normal path to the ball, and was gradually displaced as the cycle progressed, until it reached its extreme position at 45 degrees to the axis, just before the rupture of the arc.

Definite results were obtained only while the platinum surface was new and bright. The region where the normal arc left the ball soon became tarnished and corroded, and there was an increasing tendency on the part of the oblique arc to leave its own path and join the other.

When the ball was supplanted by a platinum wire, 1 mm. in diameter, with rounded tip, the object being to force the two discharges into a common path, it was found that the arc from the point (positive) avoided the end of the wire altogether, and struck in upon the cylindrical surface beyond. When the end of this wire was surrounded by an insulated platinum ring which was connected with the terminal of the induction coil by a separate wire—the invention being, if possible, to separate the two phases of current and conduct then over different wires—it was found that the arc from the point (positive) always entered the central wire, never being diverted to the ring, although the intervening air-space was less than a millimetre. The returning arc, however, would sometimes leave the ring and sometimes the wire, and a galvanometer placed in the circuit between the ring and the induction coils, showed a large deflection, such as would be caused by a flow of current towards the ring. This result seems to be in accordance with the conclusion reached from the inspection of the images in the revolving mirror, namely, that the arc from the point always formed first along the shortest path. Deflection from that path in the case of the wire and ring would probably be hindered by the insulating medium which intervened. When, finally, a cluster of points were opposed to the single point, it was found that the discharge from the latter was always along a single path, whereas the return arc from cluster (positive) often followed several paths.

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* Faraday: "Experimental Researches," §1,493.

† Weidemann and Rühlmann; Annalen der Physik und Chemie, cxlv. See also Weidemann: Elektricität, iv., p. 462.

‡ Alexander Macfarlane: Proceedings of the Royal Society of Edinburgh, vol. x., p. 555. 1879-80.

§ Frank Cary Caldwell. A Study of the Alternating Arc between a Ball and Point. Thesis in MS. Library of Cornell University, 1890.

It had been noted by Messrs. Archbold and Teeple that the platinum point used in their experiments, which was red hot while the arc was passing in both directions, became white hot during the "one-way" stage. The heating effects at the surface of the brass ball were not discernible, but when Mr. Caldwell substituted a thin sheet of platinum for the ball, this became incandescent under the action of the arcs. The spot where the oblique arc (point positive) impinged upon the foil became white hot, while that at which the normal arc (ball positive) left the foil was barely red hot. In this respect, then, the discharges act like the ordinary sparks of the influence machine or induction coil, which, as has been shown by Despretz, Poggendorf, Naccari, and other observers, heat the negative electrode to a higher degree than the positive one. This action is in marked contradistinction to that of the continuous current arc, the positive terminal of which takes the higher temperature.

In this brief account of Mr. Caldwell's experiments, I have omitted to mention many of the observations recorded by him. He had occasion, in the course of his investigation, to study the discharge under a variety of conditions, and found that when liquid surfaces (mercury or water) were used in place of the ball, also that when hydrogen, carbon-oxide, or illuminating gas were substituted for air as a dielectric, the ball and point effect, more or less modified, could still be obtained. The investigation of these points, although it has already led to some results of significance, is as yet very incomplete.

STORMS AND TELEGRAMS.

By W. SLINGO and A. BROOKER.

(*Continued from page* 139).

The principal cause which prevents a high rate of working being attained on underground lines is the retardation of the signals, due to the great electrostatic capacity of such lines. Every telegraph wire may be regarded as a condenser, whose inner coating is the wire itself, the outer coating being the earth, and the electrostatic capacity of such a line is directly proportional to the extent of the surface of the wire, and to the thinness of the dielectric separating the wire from the earth. The capacity of an overhead line is manifestly very low, its distance from the earth being comparatively so great. But an underground wire is, as a rule, only separated from the outer conducting coating by a thin layer of gutta-percha, and, as may be readily imagined, its capacity is considerable. Now, the rate at which pulsations of current can be transmitted through a wire has been shown* to be inversely proportional to its capacity multiplied by its resistance; and it becomes a very expensive matter to keep the product of these two factors low in an underground line. If, for example, the size of the wire be increased, with the object of reducing the resistance, the percha coating must be very considerably thickened in order to retain the same capacity, for not only is the surface of the wire increased in amount but its distance from the outer coating is also diminished, if the external diameter remains unaltered.

It is also evident that the speed of signalling on a line of uniform construction throughout must be inversely proportional to the square of its length, for if the length be doubled, both the resistance and capacity are likewise doubled, whence the product of capacity and resistance becomes four times as great. Furthermore, the insulation of a good underground line is practically perfect, and the whole of the discharge must take place at its extremities, the effect being a tendency to prolong and distort the signals. The introduction of a leak, say, in the middle of the line, affords, however, another path for the discharge, and hence it can be said to increase the speed of signalling attainable. The great necessity for the prompt appearance of a signal at the distance station, and its speedy disappearance to make room for another, will perhaps be better appreciated when we call to mind the fact that a Wheatstone transmitter when its governor is set to run at the rate of 400 words per minute, sends to line during one minute no less than 19,200 separate currents in alternate directions. It may be mentioned that the resistance of the underground wire employed in England is about 24 ohms, and its electrostatic capacity when laid is about one-third of a microfarad per mile.

It will be seen, from a consideration of these points, that it would be of little use to attempt to simply replace existing overhead lines by underground ones, as has hitherto been proposed. Neither would it be of any practical use to merely provide a certain number of such lines to fall back upon in case of a collapse of the overhead system. To be of any real service in such an emergency, the spare wires must certainly be capable of being worked at a high speed, whereas they would for long lines be only able to carry signals at the rate of, say, 40 or 50 words per minute. Under such circumstances, the number of underground lines would have to be made approximately equal to the number of existing overhead wires, but the enormous expense involved in such a stupendous undertaking would be certain to preclude the possibility of such a revolutionary step ever being taken. If any system of underground work is to be adopted, it must be capable of carrying the whole of the traffic, at least between important centres, and we are convinced that there is a great field open for the judicious employment of such wires, although after a manner somewhat different from that hitherto suggested. It may not, therefore, prove altogether uninteresting if we extract a few details from a scheme which we some time ago, in moments of relaxation, endeavoured to elaborate to meet the requirements of the whole kingdom.

The places where short lengths of underground line could be immediately applied with the most strikingly beneficial results are at the ends of certain submarine cables, which now are connected to the station nearest the shore by a few miles of overhead line. It thus happens that the two nearest stations to the cable at which tests can be quickly made are separated from the cable by a length of land line at either end; and when a fault occurs between these stations it frequently takes some little time to decide on which side the fault lies, or whether, indeed, it exists in the overhead sections or in the cable itself. An experienced man can, of course, in most cases quickly decide the matter by testing, but such a man is not always available, and accurate testing is frequently rendered difficult by the heavy loss of current on the land section; for it must be remembered that the insulation of lines near the sea shore is always low and variable, on account of the sea spray, which leaves a deposit of damp salt on the insulators and arms, and so covers them with a fairly good conductor. As a rule, the true locality of a fault has to be settled by a visit to the cable end, in order to enable the land section to be tested separately, or a reliable test of the cable to be made from this point. All such doubts, and the consequent delay in the removal of faults, would be avoided by the substitution of underground wires for such sections, and a further great advantage would ensue in the case of lines worked duplex, more especially where the nearest office to the cable is a relay or repeater station. Here, as is well known, it becomes necessary to form, by means of resistance coils and condensers, artificial lines whose capacity and resistance are adjusted so as to be exactly equal to that of the real line. The line on the cable side is always, as might be anticipated, the more difficult to imitate, but if the cable were led directly, by means of an underground conductor, into the repeater station on either side of the water, this artificial line could be arranged and adjusted once for all. As matters at present frequently stand, the length of overhead work between the cable and the repeater station is in a situation peculiarly liable to great changes in insulation, necessitating a frequent adjustment of the artificial line in order to correspond to such variations. The advantage gained would, we doubt not, more than compensate for the slight increase in electrostatic capacity, due to the addition of a few miles of underground work.

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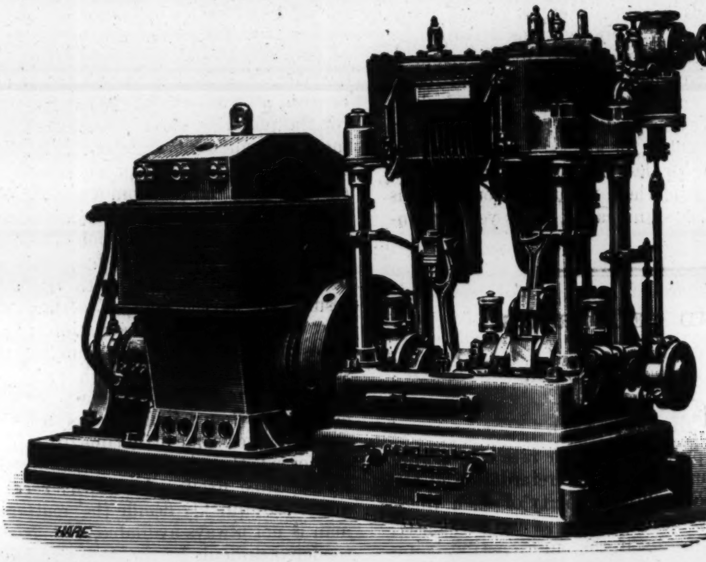
* See various papers by Mr. W. H. Preece and Mr. H. R. Kempe.

The repeaters above referred to have, in England if nowhere else, been brought to a high standard of perfection for fast-speed working, and form a very important factor in the scheme. It ought, perhaps, to be observed here that a repeater is a set of apparatus inserted at about the middle of a long line. If the line be very long, the number of repeaters is increased accordingly. The currents arriving from the sending station pass through the coils of an exceedingly sensitive relay, and then go direct to earth. These currents impart to the relay tongue a motion precisely similar to that of the lever of the original sending apparatus, and the tongue is thus pressed against contact points connected to batteries, so that it sends forward to the receiving station currents which are precisely similar in character and duration to those sent by the forwarding station. The line is thus, to all intents and purposes, divided into two sections, each of about half the total length, and remembering that the factors which tend to reduce the speed of working vary as the square of the length of the line, the advantage will be apparent. Of course, a little loss occurs on account of the friction and inertia of the relay tongue and the inductance of the coils, but there is also the fact to be borne in mind that in the absence of the repeater it would be necessary to employ a battery of about double the electromotive force at the sending station, in order to produce currents of a given strength at the receiving office. It may be observed that the "charge" imparted to the line varies directly as the E.M.F.



Under ordinary circumstances a single repeater suffices for our land lines. Thus, on a London-Aberdeen wire, the apparatus is inserted at Newcastle-on-Tyne, and at Preston on a London-Glasgow wire. Wires to the continent, however, frequently have two or more repeaters. On the London-Rome wire, for example, repeaters are inserted at Paris, Lyons, Turin, and Florence, so that the line is practically divided into five circuits.

We shall have occasion in our next contribution to enlarge upon this question of repeaters; but, reverting to the subject of a systematic adoption of underground lines, we may say again that in all probability the lines which maintain communication between London and the continent would be among the earliest to receive attention; in fact, it will probably be remembered that after the big collapse of 1886 the demand for an underground reserve was almost as strong from Germany as at home. It is doubtful whether the longer of the German cables landing at Lowestoft could be worked with ease, as at present, if underground work were employed the whole of the distance from London to Lowestoft; but in the case of a complete collapse the latter could, if necessary, be made a transmitting station, while, for ordinary interruptions, the underground lines would be invaluable for the repair of sections, as indicated presently. Coming south, the French cables present less difficulty. There is already a length of underground line about 14 miles in length carried to a point beyond Bromley; the addition of 56 miles or thereabouts would place London in underground communication with Beachy Head, where two six-wire cables land, and these could be worked as easily as at present by the insertion of repeaters at the Beachy Head repeater station. The shorter cables landing at Dover present even less difficulty, and repeaters at that station would render communication with the Hughes apparatus at present employed quite as easy through an underground line from London to Dover, as at present.

(*To be continued.*)

OPEN ENGINES IN THE NAVY.

OWING to the difficulties which have so frequently occurred with the closed type of engines formerly used almost exclusively in the navy for electric light machinery, the Admiralty have abolished them in their recent ships, and have substituted open engines of the compound type.

Our illustration shows one of a set of nine which Messrs. G. E. Belliss & Co., of Birmingham, have recently completed for the new battle ships. The firm have already supplied, during the last year or two (since the open type of engine has been adopted), about twenty of these sets of dynamo machinery for various ships of our navy, and the official trials at Portsmouth have given complete satisfaction. The engine is well balanced, the cranks being opposite, and the valves arranged to give the amount of compression required for economy and quick running.

The makers have aimed at producing an engine capable of running for long periods without requiring adjustment, and with such simplicity of parts as shall render the liability to damage as small as possible and give the utmost facility for adjustment or repair. The cylinders are supported on four stout steel columns, fitted into long sockets, accurately bored to correspond in cylinder and bedplate. The guides are carried on the cylinder casting, and are designed to be very readily adjusted. The piston valves are placed at the back of the engine, and driven by a single lever arrangement from the H.P. connecting rod. The governor is placed at the end of the crank shaft, and is capable of controlling the engine to within 3 per cent. of the maximum revolutions when the full load is thrown suddenly off.

The engine and dynamo are carried upon a combination base-plate, and each set is subjected to thorough working tests at Messrs. Belliss & Co.'s works, where a very complete installation of electrical resistances and recording instruments have been fitted for the purpose.

Each set supplied for service in our navy is also subjected to official tests at Portsmouth Dockyard for six hours' continuous running at full power, with a guaranteed minimum consumption of water per E.H.P. per hour, and the effectiveness of the governor and general perfectness of the whole construction and suitability for the service is determined. The illustration shows the engine in combination with a Siemens dynamo, but dynamos of other design and construction are fitted by Messrs. Belliss & Co. to their engines as may be required. We understand that they purpose to exhibit at the forthcoming Naval Exhibition some of their specialities in these things, and we have no doubt the simplicity and excellence of the design will attract the attention of all who are interested in this department of engineering.

HELLESEN'S PATENT DRY ELEMENTS.

THE want of an efficient dry battery has long been felt in both telegraphic and telephonic services, and, perhaps, even more especially for use in houses in connection with electric bells. After numerous unsatisfactory proposals, which failed to fulfil the requirements, greater success has been obtained during the last few years, and dry batteries which give general satisfaction are now coming into extensive use. It is evident that in cases where the liquids are subject to rapid evaporation, or where it is desirable to employ elements which, after their installation, require no further attention, and also in cases where portability is a condition to be fulfilled, dry elements will undoubtedly find their special field.

On the suggestion of Prof. Lommel, of the physical laboratory of the University of Munich, a series of experiments were conducted in November, 1889, by Mr. Heinrich Krehbiel, Dr. Narr and Dr. Donle, in order to obtain an exhaustive comparison of the electrical qualities of six of the principal dry elements in existence, viz., those of Hellesen, Bender, Thor, Gassner, Jenisch and Wolfschmidt.

A full report of these interesting experiments was published on the 1st of August, 1890, in No. 31, Vol. 11, of the *Elektrotechnische Zeitschrift*, of Berlin, containing a detailed account of the following investigations :—

1. Change of the electromotive force of the element on open circuit.
2. Variation of electromotive force with temperature.
3. Determination of internal resistance.
4. Fall of electromotive force on a closed circuit, and subsequent recovery on open circuit, under the following conditions :—

(*a*) With an external resistance of 3 ohms, furnishing a strong current ;

(*b*) With an external resistance of 50 ohms, furnishing a weak current.

As the complete report of the Munich University is a very lengthy document, we only extract from it the principal data referring to that element which proved the most satisfactory, viz., Hellesen's, and quote only such results with regard to the other elements as enable their respective efficiencies to be directly compared with that of Hellesen's cell.

The electromotive force was measured by an Edelmann's cylinder quadrant electrometer, by comparison with a Latimer Clarke's standard cell of 1·407 V (the coefficient for reducing the electromotive force to the standard temperature being taken as 0·08 per degree Centigrade, as given by Helmholtz and Kittler).

The measurement of resistances was effected by Kohlrausch's method, using alternate currents, with the telephone introduced into the bridge. The Hellesen's cells had the following dimensions :—8 cm. square by 16 cm. high (3¼ inches square by 6½ inches high).

The mean original electromotive force in volts at 15° C., taken immediately after the receipt of the cells, was 1·415 V.

The electromotive force of each cell was tested periodically during 2½ months, and remained with slight variations practically constant, no current, however, being taken from the cells during the time.

The electromotive force was at 0° = 1·405 V. ; at 15° = 1·404 V. ; and at 30° = 1·404 V. ; showing that the electromotive force was practically unaffected by change of temperature.

The mean original internal resistance, taken immediately after the receipt of the cells, was 0·067 ohm ; this resistance being lower than that of any of the other cells submitted for testing.

After these tests one element of each kind was continuously closed for 36 hours through an external resistance of 3 ohms and periodically tested ; the results obtained with Hellesen's cell being the the following :—

At the beginning	0·066 ohm.
After ½ hour	0·071 „
„ 1 „	0·074 „
„ 4 hours	0·087 „
„ 8 „	0·096 „
„ 12 „	0·105 „
„ 36 „	0·172 „

The experiments proved that all the elements increased somewhat in resistance, when short-circuited in this way for a long time.

The next and most important trials refer to the recuperative power possessed by these cells. For that purpose they were closed for 60 minutes through an external resistance of 50 ohms, after which time the circuit was opened and the amount of recovery observed at intervals. This closing and opening of the circuit was repeated 25 times, the circuit of each element being closed for 60 minutes at a time, and the elements then left on open circuit for 24 hours, thus imitating in some degree the demands required in actual work.

The following table shows the decrease of the electromotive force during the 60 minutes of closed circuit and the recovery during the 24 hours of open circuit given by the first of these 25 tests.

HELLESEN'S ELEMENT.

Closed.			Opened.		
Time of closing.	v.	Per cent.	Time of opening.	v.	Per cent.
0 minute	1·420	100	2 minutes	1·394	98·2
2 minutes	1·405	98·9	5 „	1·397	...
5 „	1·402	...	10 „	1·397	...
10 „	1·399	...	20 „	1·398	...
20 „	1·398	...	30 „	1·399	...
30 „	1·397	...	60 „	1·402	...
60 „	1·391	98·0	24 hours	1·411	99·4

Time of closing and opening.	Hellesen.		Bender.		Thor.		Gassner.		Jenisch.		Wolfschmidt.	
CLOSED.	V.	Per cent.	V.	Per cent.	V.	Per cent.	V.	Per cent.	V.	Per cent.	V.	Per cent.
0 hour	1·379	100	1·371	100	1·360	100	1·373	100	1·286	100	1·000	100
1 „	1·347	97·7	1·327	96·8	1·295	95·2	1·266	92·2	0·859	66·8	0·542	54·2
4 hours	1·306	...	1·298	...	1·256	...	1·208	...	0·725	...	0·413	...
24 „	1·260	...	1·240	...	1·173	...	1·115	...	0·594	...	0·307	...
48 „	1·241	...	1·219	...	1·112	...	1·004	...	0·521	...	0·290	...
72 „	1·224	...	1·204	...	1·067	...	0·887	...	0·474	...	0·287	...
96 „	1·207	87·5	1·192	86·9	1·033	75·6	0·842	61·3	0·436	33·9	0·286	28·6
OPENED.												
5 minutes	1·209	...	1·199	...	1·038	...	0·851	...	0·485	...	0·339	...
60 „	1·214	...	1·222	...	1·071	...	0·864	...	0·564	...	0·366	...
24 hours	1·297	94·1	1·280	93·4	1·169	86·0	1·071	78·0	0·950	73·9	0·412	41·2

All the elements after 24 hours of open circuit regained very nearly their original electromotive force.

The electromotive force before the 25th test, and its value as compared with the first test was as follows :—

Volts 1·369 = 96·4 per cent.

A far more crucial test was then made by closing each element continuously for 96 hours through an external resistance of 50 ohms, after which time the circuit was opened for 24 hours, and the amount of recovery observed. The results are contained in the foregoing table.

According to the above table, the Hellesen element suffered the least loss in electromotive force after 96 hours' work on closed circuit, retaining 1·207 V., or 87·5 per cent. of its original value; but the table also shows that the Hellesen element possessed the greatest recuperative power, attaining after 24 hours' rest, 1·297 V. or 94·1 per cent. of the original value before the 96 hours of closed circuit.

After these experiments were brought to a close, a final test was taken by closing the cells for 60 minutes through an external resistance of 50 ohms, and then leaving them open for 24 hours. The following table gives the electromotive force in volts during this test :—

Time.	Hellesen.	Bender.	Thor.	Gassner.	Jenisch.	Wolfschmidt.
CLOSED.						
0 min.	1·361	1·359	1·312	1·284	1·243	0·476
5 mins.	1·343	1·332	1·265	1·205	1·017	0·343
30 „	1·338	1·318	1·217	1·184	0·906	0·277
60 „	1·321	1·309	1·189	1·170	0·865	0·267
OPENED.						
24 hours.	1·349	1·352	1·304	1·285	1·225	0·475

The Munich investigation contains also the calculations of the ampère-hours from the values of current observed, and thus of the amount of work done by each element.

The following table gives the ampère-hours of the first, ninth, seventeenth and twenty-fifth period of 60 minutes, when the circuit was closed through an external resistance of 50 ohms.

Closing Period.	Hellesen.		Bender.		Thor.		Gessner.		Jenisch.		Wolfschmidt.	
	Ampère hours.	Per cent.	Ampère hours.	Per cent.	Ampère hours.	Per cent.	Ampère hours.	Per cent.	Ampère hours.	Per cent.	Ampère hours.	Per cent.
1st.	0·0279	100	0·0284	100	0·0280	100	0·0285	100	0·0197	100	0·0260	100
9th.	0·0274	98·1	0·0276	97·0	0·0267	95·2	0·0276	96·9	0·0189	96·0	0·0243	93·4
17th.	0·0271	96·9	0·0272	95·6	0·0264	94·2	0·0268	94·0	0·0186	94·2	0·0147	56·6
25th.	0·0270	96·7	0·0267	93·9	0·0260	92·7	0·0257	90·3	0·0182	92·2	0·0109	42·1

The above table demonstrates the superiority of the Hellesen element, the value of the ampère-hours during the twenty-fifth period being actually 96·7 per cent. of that furnished during the first period of closed circuit. This superiority is still more clearly shown by the ampère-hours which were furnished by the crucial test of the 96 hours on closed circuit, and which are as follows :—

Hellesen	... ...	2·3915 ampère hours.
Bender	... ...	2·3400 „ „
Thor	... ...	2·1435 „ „
Gassner	... ...	1·9374 „ „
Jenisch	... ...	1·0347 „ „
Wolfschmidt	... ...	0·5967 „ „

The ampère hours resulting from the final test and the percentage in value compared with that of the very first period of closed circuit are given below, and here also the superiority of the Hellesen element is maintained; the elements having been on closed circuit for more than five days, four days of this being continuous.

Hellesen	... ...	0·0267 ampère hours,	95·6 per cent.
Bender	... ...	0·0262 „ „	92·1 „
Thor	... ...	0·0242 „ „	86·4 „
Gassner	... ...	0·0237 „ „	83·2 „
Jenisch	... ...	0·0183 „ „	92·8 „
Wolfschmidt	...	0·0058 „ „	22·4 „

In the foregoing experiments the circuit was closed through an external resistance of 50 ohms, but similar experiments were at the same time carried out through an external resistance of only 3 ohms. In these latter experiments the time of closed circuit was, however, only 30 minutes instead of 60 minutes; the number of periods being as before 25 respectively at intervals of 24 hours each.

The results obtained with Hellesen's cells after the first period of 30 minutes' work and 24 hours' rest are given in the following table, and it appears that the Hellesen's element suffers the least polarisation.

Time of Closing.	Hellesen.		Time of opening.	Hellesen.	
	v.	Per cent.		v.	Per cent.
0 minute	1·410	100	2 minutes	1·288	91·3
2 minutes	1·343	95·2	5 „	1·295	...
5 „	1·325	...	10 „	1·303	...
10 „	1·305	...	15 „	1·314	...
15 „	1·299	...	20 „	1·317	...
20 „	1·274	...	30 „	1·323	...
30 „	1·261	89·4	60 „	1·332	...
...	...	...	24 hours	1·385	98·2

The following table shows a similar but more severe test than that of the preceding table, the elements having been close-circuited during 24 hours through an external resistance of 3 ohms, and then given 24 hours' rest.

Time of closing.	Hellesen.		Time of opening.	Hellesen.	
	v.	Per cent.		v.	Per cent.
0 hours	1·298	100	5 minutes	0·605	...
1 hour	1·007	77·6	60 „	0·776	...
4 hours	0·853	...	24 hours	1·084	83·5
24 „	0·344	26·0	...	...	...

The next table gives the values of ampère hours at the first, ninth, seventeenth and twenty-fifth period when closed through an external resistance of 3 ohms. The duration of each period being 30 minutes.

Closing Period.	Hellesen.		Bender.		Thor.		Gassner.		Jenisch.		Wolfschmidt.	
	Ampère hours.	Per cent.	Ampère hours.	Per cent.	Ampère hours.	Per cent.	Ampère hours.	Per cent.	Ampère hours.	Per cent.	Ampère hours.	Per cent.
1st	0·2120	100	0·1959	100	0·1959	100	0·1943	100	0·0861	100	0·0948	100
9th	0·2015	95·0	0·1801	91·9	0·1656	84·5	0·1585	81·6	0·0823	95·6	0·0612	64·6
17th	0·1872	88·5	0·1761	89·9	0·1495	76·3	0·1308	67·3	0·0797	92·6	0·0401	42·3
25th	0·1779	83·9	0·1619	82·6	0·1206	61·6	0·1138	58·6	0·0762	88·5	0·0316	33·3

The elements when closed during 24 hours through an external resistance of 3 ohms gave the following aggregate ampère hours.

Hellesen	5·0792 ampère hours.
Bender	4·9898 „
Thor	3·4552 „
Gassner	2·6670 „
Jenisch	1·2236 „
Wolfschmidt	1·6168 „

This investigation of the comparative efficiency of the above elements was concluded by the experiment of regenerating the partially exhausted cells by a treatment similar to that of a secondary battery, *i.e.* by sending a current from two Bunsen elements during two hours through the cells. The elements thus regenerated were again worked for five periods of closed circuit (each period of 30 minutes, duration) through an external resistance of 3 ohms.

The following table shows the electromotive force of the partially exhausted Hellesen cell before and after its regeneration by the two Bunsen elements, and also the electromotive force of the last period of closed circuit, with the recovery after being on open circuit for 24 hours.

ELECTROMOTIVE FORCE IN VOLTS.

		Hellesen.
Before	Regeneration.	1·225
Immediately after		1·994
24 hours after		1·580
CLOSED through 3 ohms.		
0 minutes		1·352
5 „		1·096
20 „		1·008
30 „		0·979
OPENED		
24 hours		1·309

The ampère hours calculated from the results of this last test after the regeneration, and the percentage of the value of the last period before regeneration, were found to be as follows :—

Hellesen	0·1656 ampère hours	= 172·9 per cent.
Bender	0·1384 „ „	= 114·3 „
Thor	0·1005 „ „	= 148·9 „
Gassner	0·1590 „ „	= 151·0 „
Wolfschmidt ...	0·0556 „ „	= 134·9 „

The Munich report contains the following conclusion as the results of this exhaustive and carefully conducted series of experiments :—

"The most efficient elements, even for circuits of a small external resistance, are Hellesen's and Bender's elements. Hellesen's element excels Bender's by having somewhat less polarisation and much smaller internal resistance ; it has, however, when exhausted by long working, not quite so much recuperative power as Bender's.

"A similar relationship exists between Thor's and Gassner's element. In a circuit with a small external resistance, Gassner's is less constant than Thor's, but the former has the advantage of more recuperative power, even after the electromotive force has been reduced to a very small value.

"Jenisch's and Wolfschmidt's elements are, in consequence of their very rapid polarisation, unsuitable for giving even approximately constant currents ; hence they are only applicable when the duration of closed circuit is very short."

The above experiments prove that dry elements are well adapted for many practical purposes, especially for telegraphic, telephonic and similar services, and the considerable powers of recovery possessed by such elements gives them a long duration of life.

Hellesen's elements being able to produce strong currents during a long period, are well adapted to supersede the cells of Leclanché, Meidinger and similar types, and in many cases even those of the Daniell type.

Besides the electrical advantage shown in the tables accompanying the Munich report, there are various other advantages of a purely practical character possessed by such cells when compared with wet elements.

The former are transported with far more facility, being always, and without any previous preparation, ready for use, and require no inspection or attention until they are completely exhausted.

Messrs. Siemens Brothers & Co. are the sole manufacturers in England of Hellesen's patent elements.

MR. CROOKES'S PRESIDENTIAL ADDRESS.

BY S. ALFRED VARLEY

No. II.

THE passing reference to the molecular theory of gases made by me in my article on Mr. Crookes's address has led to certain comments and questions which it has seemed to me could be better dealt with in a communication than in the form of a letter. I am not sure that I clearly grasp the contention of my critic, but I think the spirit of it is, given constant pressure and constant temperature, that the gaseous molecules, on the assumption that they bombard one another, would simply give and take energy ; in other words, that being perfectly elastic, no transformation of energy would result from the mutual bombardment of gaseous molecules.

I do not propose to argue the question, but proceed at once to try and express more clearly what was in my mind at the time I wrote the passage which has been criticised. Assume a pendulum under the influence of gravity, but suspended frictionlessly in absolute space, and there will be no power within the pendulum itself to set up motion ; but if the bob be raised in opposition to the force of gravity, and then be set free, oscillations will be set going by the combined forces of the energy imparted to the pendulum bob and the action of gravity. Under such assumed conditions, the pendulum would oscillate for ever, the amplitude of the oscillations being all of them equal ; eliminate gravity, and bob of the pendulum will cease to oscillate, but the rod and point of suspension will be subject to stress proportionate to the energy imparted to the pendulum. It should not be overlooked that gravity was the fulcrum which enabled the pendulum bob to be lifted, and that although the raising of it has involved an expenditure—more correctly a transformation of energy—the act of lifting it has not imparted any energy to it ; lifting the bob is simply altering its position in respect to the earth in such a way as to enable gravity to act upon it, the point of suspension of the pendulum now becomes the fulcrum which enables the force of gravity to act upon the pendulum bob. I have dwelt on this matter because it seems to me not to be very clearly grasped, the idea often appearing to be that when you lift a weight, you impart energy to it. What really occurs is a transformation of energy in the person himself who lifts the weight, the equivalent of which is represented by the mass multiplied by the height to which it has been raised in opposition to the force of gravity. Increasing the distance between a mass of matter and the centre of the earth is suggestive of what takes place when, say, an india-rubber cord is extended.[*]

Now assume two gaseous molecules in absolute space propelled against one another by equal amounts of energy, the effect of striking one another would be to reverse the direction of motion, the molecules separating farther and farther from one another.

In the case of, say, our atmosphere, the gaseous molecules are under the influence of two forces, viz., energy and gravity ; the former tends to push the molecules apart, and the latter pulls them towards the earth, and the consequence is that the molecules are under a condition of stress, impart additional energy to the gaseous molecules, and they become separated farther apart ; increase the force of gravity, and the molecules are brought closer together. Now I am disposed to regard gaseous molecules as elastic springs, and that they do not possess the power of indefinite expansion, for the logical outcome of the present theory seems to me that our atmosphere should diffuse itself throughout space and leave the earth altogether ; at the same time I confess I am sorry that I have involved myself in an argument on the molecular theory of gases, for arguments of such nature are at the best simply mental exercises which seldom lead to results of any practical value.

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[*] In gaseous matter energy is combined with matter, but in the case of matter in motion it is only associated with it.

The present theory of matter is more or less connected with the agnostic theory of creation, and it seems in effect to be assumed that in some mysterious manner matter possesses the power to change its own properties; for example, our physicists admit that matter attracts matter, but at the same time they assume that molecules in the gaseous condition can set up a repulsive force when approaching one another, and the general outcome is that the atoms of matter and their associated forces are the only immortal entities in existence, and that they possess within themselves the power to create solar, stellar, and terrestrial systems, and it logically follows vital organisms also.

If I were asked to define theorists as contrasted with practical men, I should describe the best examples of both as possessing mental capacity in an equal degree, the chief difference between them being that the one thinks he knows and the other recognises the fact that he does not know. It is contended that those who are capable of realising how little they really do know are the more receptive to the teachings of our great Schoolmaster, Nature, and that being so, they, on the whole, make fewer mistakes. The following passage occurs in a published letter of Dr. Silvanus Thompson in the *Electrician* of the 23rd ult.:—"Only a half-educated electrician would dream of applying a law that is true of steady currents to currents that are not steady;" but this is what the distinguished physicists who formed the British Association Unit Committee did do, until such time that Lord Rayleigh called attention to the errors which had been made, and I suppose Dr. Silvanus Thompson would hardly describe Sir William Thomson or the late Fleming Jenkin even, as half-educated electricians. Now, I myself became acquainted, in a very practical manner, in 1856, with the difference of behaviour of transient and steady currents by observing what followed as a consequence of a lightning discharge striking a telegraph wire and bursting up the apparatus. What then took place taught me the conditions which lightning protectors should be designed to fulfil. In 1859 I had to deal with inertia resistance in connection with telegraph circuits under another aspect, and my late brother, C. F. Varley, was well aware of the inertia opposed by all electric circuits, but more especially electro-magnetic circuits, and he turned it to account when designing his translating apparatus. In 1862 I observed that no two different samples of copper, although adjusted to an equal resistance, had precisely the same action on a galvanometer when a current divided itself through them. A few years later this fact was generally known and intelligently dealt with by manufacturers of differential galvanometers, nevertheless it was overlooked by our physicists.

The opportunities possessed by endowed scientific professors for making purely scientific advances are much greater than those possessed by a busy practical man, and they ought to lead the way, as Faraday did. That they do not do so arises, I believe, from the character of their education, which results in an almost entire devotion of their energies to mathematically investigating mental assumptions. Work of such description is for the most part simply a mental exercise; it may be of a very high order, but nevertheless (so far as real progress is concerned) of very little more practical value than clever chess-playing.

Exception has been taken to my speaking of the + pole of an induction coil. Of course it is generally known, although my critic, "N. S.," would not seem to be aware of the fact that when the secondary circuit of a Rhumkorff coil is closed through a path of great resistance, such as that opposed by high vacua and air spaces, that the discharges are in one direction only.

I have discussed this matter at considerable length in previous communications, for it is a subject I have gone into deeper than, I think, any of our physicists, as I hold that it forms the basis of the dynamo, and also of transformers. Whether the views I have published have been grasped by our physicists generally I cannot say, but one at least who writes much, talks glibly, and does not consider himself half-educated, had the good taste to describe my views as *absurd*, when giving evidence in the Law Courts, but there is unfortunately abundant evidence forthcoming to demonstrate that our learned physicist's confidently expressed opinions, have not any real claims to be considered infallible.

Perform the following experiments:—Transmit rapidly one after the other a series of transient currents of short duration through the primary wire of an induction coil, including a galvanometer in the circuit; when the circuit is open it will be observed that the energy unlocked in the galvanic battery and transmitted through the primary wire, as indicated by the galvanometer, is much less than when the secondary circuit is *metallically* closed; and that being so, it is evident that the closing of the secondary circuit, which, it may be remarked, is electrically insulated from the galvanic battery and the primary wire, has in some way or other reduced the resistance opposed to the passage of transient currents. The explanation which has been given in previous communications of this phenomenon is that when the secondary circuit is open, the passage of current through the primary wire involves magnetising the iron core; in other words, energy has to be occluded in the iron before current can pass, and this involves time; but when the secondary circuit is closed the energy, instead of being stored, seems to rebound, passing through the secondary circuit, where it becomes dissipated in the form of heat through the medium of current which it develops, and as the closed secondary circuit affords an outlet for the dissipation of energy, there is not nearly so much resistance opposed to the unlocking of energy in the galvanic battery.

The specific inertia resistance of copper is probably many hundreds of times less than that of iron; were it possible to obtain copper having no inertia resistance, then no magnetism whatever would be developed in the soft iron cores of transformers when rapid alternations are being sent through the primary circuit, assuming, of course, that the secondary circuit is closed metallically by a short conductor. All circuits, especially when in the form of solenoids, do, however, oppose inertia resistance, and in proportion as they do so relatively to the inertia resistance of the iron core, magnetism becomes developed in iron cores of induction coils and transformers.

If the terminals of the secondary circuit of a Rhumkorff coil be joined together by a wire, alternate currents will be developed in it when the battery circuit is closed and opened through the primary wire; but when an air space divides the two ends of the secondary circuit, inertia resistance is opposed in the primary one, checking to a considerable degree the unlocking of energy in the galvanic battery, as the occlusion of energy in the soft iron core occupies time. The magnetism developed in the iron is the equivalent of the energy occluded, and when the soft iron core has become magnetised sufficiently highly the armature is attracted and the circuit divided by the make and break. The energy occluded in the iron (in the shape of magnetism) now becomes rapidly dissipated through the medium of current developed in the secondary wire, the voltage of this current being determined by the amount of energy previously occluded in the iron core, the number of convolutions in the secondary wire, and the rapidity with which the iron becomes demagnetised by the discharge of the statically occluded energy. Now, as the number of convolutions in the secondary wire is very great, and the interval of time in which the demagnetisation is effected is very small, the voltage is raised high enough to create a path through an air space.

It has been already stated that when transitory currents are being transmitted through the primary wire of an induction coil, the secondary circuit being closed at the time, that the energy unlocked in the galvanic battery seems to rebound from the iron core through the secondary wire, instead of becoming statically occluded in the iron. We have here an illustration of the transmission of energy through space. Energy is unlocked chemically, developing current in the primary circuit, and energy is dissipated through the medium of current set up in the secondary circuit, such current being in the opposite direction to that of the primary one.

Those who are capable of looking at physics as one great whole, cannot fail to be struck with the resemblance of what has just been described to that of, say, an elastic ball propelled in what we may call a primary path, and which encountering an obstacle rebounds through a secondary one, where the greater percentage of the energy which set the ball in motion becomes dissipated.

In the case of the elastic ball, the vehicle of energy travels through both the primary and secondary paths, but in the case of an induction coil or a transformer, the vehicle of energy, viz., electricity, does not travel from one path to the other, and the fact that the electricity does not do so supports the contention of the writer put forward in previous communications, that it is energy *only*, and *not* electricity, which is transmitted by lightning discharges, dynamos, and transformers.

Now, assuming that the development of secondary currents in induction coils or transformers is due to a rebound of energy from the iron core, then the explanation of the temporary resistance opposed in the primary wire when the secondary circuit is open becomes clear enough, the energy can only rebound through the medium of current, and this involves a conducting path, and the only path available is the primary wire itself; the rebound, therefore, opposes the current the battery is developing, and consequently checks the chemical action. In certain cases where the primary circuit is a solid conductor of large section, the effect of the rebound is probably to set up eddy currents to a greater or less degree.

I have elsewhere compared the primary and secondary circuits of a transformer to that of a brattice in a mining shaft, which enables energy to be transmitted freely both ways at the same time; destroy the brattice, and instead of a transmission of energy taking place through two defined paths, the energy will become locally dissipated through the medium of eddy currents.

There is one great principle common to all physical phenomena, viz., that no work can be performed without a resisting base or fulcrum; the production of motion involves at the very least two atoms, and all motion is relative to matter; the lifting of a weight involves a base opposing inertia, and theoretically a weight cannot be lifted without moving the earth—the earth is the base or fulcrum of all mechanical machines—the inertia of magnetism is the resisting base or fulcrum of dynamos and transformers, and were it not that the specific magnetic inertia of iron is so great relatively to that of all other conducting matter, there wonld be no such thing as the economical transmission of energy through the medium of dynamos and transformers.

LONDON COUNTY COUNCIL.

THE usual meeting of the London County Council was held on Tuesday at the offices in Spring Gardens, Sir John Lubbock presiding. After dealing with some preliminary business the Council proceeded to discuss at great length the adjourned report of the Parliamentary Committee, which was published in our issue of January 23rd.

Mr. Acworth moved as an amendment on the subject of the Central London Railway, "That it be an instruction to the Parliamentary Committee not to offer evidence in support of any such purchase clause till such time as the new system of tunnelling and electric traction shall have been proved to be not only an engineering but a financial success."

A long discussion ensued but no definite decision was arrived at. A further report of the same committee contained the following:—

London, Deptford and Greenwich Tramways Bill.

This Bill proposes to authorise the construction of six new tramways, to extend the time for the completion of the lines sanctioned in 1889, to authorise the use of mechanical power, and to change the name of the company from "The Southwark and Deptford Tramways Company," into "The London, Deptford and Greenwich Tramways Company." The Highways Committee are of opinion that assent may be given to the Bill on the following condition:—That a clause be inserted (similar to section 73 of the West Metropolitan Tramways Act, 1889) fixing 19 years after the passing of the Act as the time at which the *whole* of the company's undertaking shall come under the operation of the purchase clauses of the Tramways Act; that all the Council's general tramway clauses be inserted; that a clause be inserted for securing to the water traffic through Creek Bridge precedence over the tramway traffic across the bridge; that clause 17 and other clauses be made to apply to the Creek Bridge, so that due provision may be made for protecting the interests of the Council therein; and that the Council be not made a party to the agreement in the schedule to the Bill. We concur in the opinion of the Highways Committee, and recommend—

"That upon the promoters of the Southwark and Deptford Tramways Bill giving an understanding to amend the Bill in the manner required by the Council, the consent of the Council be given to the introduction of the Bill into Parliament."

Central London Railway Bill.

City and South London Railway Bill.

The agent has prepared and submitted to us petitions against the Central London Railway Bill, and the City and South London Railway Bill, our report on which is still before the council. Until the council shall have given us further indications as to the policy to be followed in these cases, it is difficult to settle the form of the petitions, but, as the time when the petitions must be deposited is at hand, we have approved the petitions subject to any opinions to be expressed by the council, and recommend—That the seal of the council be affixed to the petitions against—(1) The Central London Railway Bill. (2) The City and South London Railway Bill.

On the subject of technical education the report states:—The City and Guilds Institute (which has not asked for any pecuniary assistance) is doing a most valuable work as regards the highest form of technical education at South Kensington, and in its excellent school at Finsbury; also it does a great deal by a system of examinations and grants to assist, organise and control technical education throughout London and the whole country. The Goldsmiths' Company has founded and endowed what promises to be a very valuable institution at New Cross. The so-called Polytechnics form an important feature in the scheme of the Charity Commissioners; of these the Northampton Institute in Clerkenwell does not call for assistance at present. The People's Palace, Mile End, which is very successful, owes a very great deal to the Drapers' Company, which will probably take over the whole financial responsibility of its technical school. The Regent Street Polytechnic has been at work for many years, and the committee received the most gratifying evidence of the value of its teaching, but it is greatly hampered for want of funds; indeed it has been hitherto chiefly maintained by the princely munificence of Mr. Alderman Quintin Hogg. Several other polytechnic institutions are in contemplation, and large sums of money have been collected, or promised for them in connection with the schemes of the Charity Commissioners. Those in the most advanced state are the Battersea and Boro' Road Polytechnics, then follow the St. Pancras, Chelsea, and Holloway Polytechnics, and other schemes are in various stages of progress.

PROCEEDINGS OF SOCIETIES.

Manchester Association of Engineers, Saturday, January 24th, 1891.

DYNAMOS: THE CONSIDERATION OF THE CHIEF FEATURES WHICH REGULATE THEIR APPLICATION.

By A. B. BLACKBURN, Assoc. M. Inst. C.E., Assistant Manager, Messrs. Mather & Platt's Electrical Department.

(*Concluded from page* 143).

In fig. 10 the results for constant speed are plotted. The volts in the shunt machine fall, whilst those in the series rise as the current rises, by employing compound winding, the mean of the two effects is obtained, and the volts can be kept practically constant over a wide range, without change of speed. By proper proportioning, the pressure can be made to rise slightly with increased load, and the fall in speed of the engine, which to greater or less degree occurs wherever mechanical governors are employed, can be compensated for, and even the varying loss of pressure with different loads in a long main conductor is under control. It is not, however, possible to compensate exactly in such cases as lighting circuits, where some lamps are close to the dynamo and some far away.

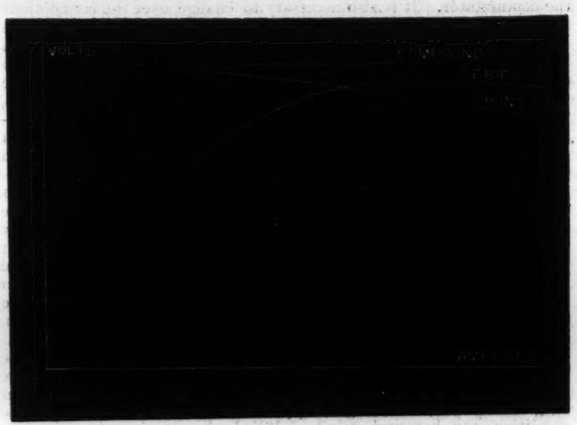


FIG. 10.—LOAD CURVES.

In machines in which the convolutions on the armature are excessive, it is necessary that the series winding bear a large proportion to the shunt, in order to compensate for the loss of pressure due to high resistance and obliquity of the field, but where the magnets are relatively powerful the correction is small. For example, in a Manchester dynamo for 100 volts and 320 ampères the series coils at full load contribute 45 per cent. of the whole magnetising current, whereas in the Edison-Hopkinson for the same output it is only 20 per cent., from which it follows that in the latter the lead is less variable.

In the series dynamo, up to the point at which the magnets become saturated, the current and pressure grow together, beyond this, supposing the speed to remain constant, the waste field and the loss due to armature resistance are both increased by the greater current, so that at the terminals the electromotive force will begin to fall away again.

The chief uses of the series machine are for motors, or for high tension for arc lights, worked in series. As a motor, where it has to be started with the load on, the resistance of the magnet coils added to that of the armatures, moderates the flow of current when switched on. There will, however, be great changes of speed with variable load, unless a regulating resistance is applied. For the propulsion of locomotives the series wound motor possesses the advantage of exerting a very powerful torque at slow speeds, as the back electromotive force generated there being small, extra current passes which not only adds to the force of the armature, but also strengthens the magnets. For arc lights the magnets should be well saturated, otherwise fluctuation in pressure and current occur with every variation in the resistance caused by the distances between the carbon points changing; when these close there is a rush of current, which, with non-saturated magnets would be still further augmented by increase of pressure, due to the consequent increased excitation, and this acting on the mechanism of the lamps would unduly separate the carbons, causing in turn an excessive fall of current.

In the shunt dynamo variation in load, as already explained, causes considerable variation in pressure in the inverse sense. Where constant pressure is required as in supplying incandescent lamps, compound machines are therefore generally employed, but where intended to run in parallel, and where changes of load are small or the engine governor is not sensitive, shunt machines answer as well. For charging accumulators they are necessary, as if by slipping of the belt or other cause, the pressure falls below that of the opposing electromotive force of the cells, the current runs back into the dynamo, making it run as a motor. This, however, in the shunt machine tends to increase the speed and checks excessive discharge, but if it were series wound the polarity would be reversed, and it would generate current in the same direction as that flowing from the cells, causing a violent discharge to the detriment of both. A shunt wound motor can be run at approximately constant speed with either full load or no load, but care must be taken to avoid such overloading as would bring it to a stand, when by all back electromotive force being done away with, excess of current would injure the armature.

In a dynamo at rest there will be little if any magnetism. After starting, excitation depends on an infinitesimal current from the armature reinforcing the field, whereby a further increment of pressure is established, and the mutual reaction soon raises the strength to the full limit. The time required depends on the residual magnetism, and on the proportion of iron to copper, and may vary from a few seconds to many minutes, being greatest in a new machine. For every speed there is a point at which the product of the current into the resistance creates an opposing force equal to the pressure generated by the armature, and no further rise of pressure can take place without increase of speed. In a series machine, as excitation is effected by the main current, the circuit must of necessity be closed, but in the shunt machine, if the main circuit be closed at starting there will often be a difficulty in exciting, unless the speed is temporarily raised above the normal, for owing to the path of low resistance offered by the main circuit, the pressure at the terminals is pulled down, and less current flows round the magnet circuit. In the compound machine, as both sources of excitation are employed, it is generally best to keep both circuits closed.

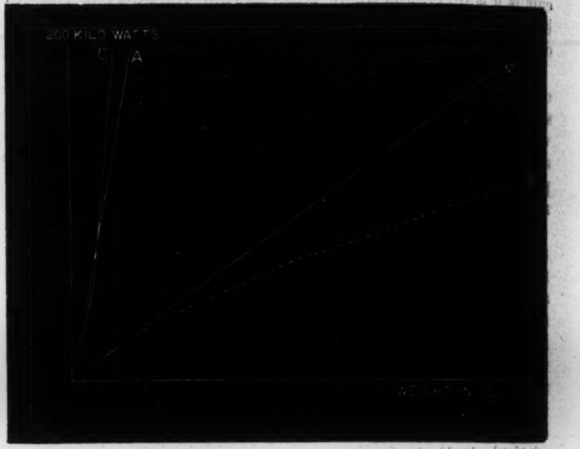
When it is desired to change the direction of rotation, the lead of the brushes has to be changed to the opposite side of the neutral line, and their inclination reversed, so as to prevent them tripping against the commutator. It is also necessary to change over the connections of the magnet coils (which is most conveniently done by crossing the leads from the brushes), for as the armature conductors now cut the lines of force in the reverse direction, the positive and negative sign at the brushes is changed, and if the connections were unaltered the reversal in the armature would change the polarity of the magnets, which would again reverse the flow in the armature, and so on *ad infinitum*. It follows that while it is immaterial which pole be north and which be south, there is only one way of connecting up for each direction of rotation with which the machine will work.

When working with the same induction, the proportion of copper to iron in various sizes of machines will remain approximately the same, and with the same peripheral velocity the outputs will be nearly as the weights. Fig. 11 shows the general form of the curve for various sizes of Edison-Hopkinson machines for from 12 to 150 electrical horse-power. It should, however, be noted that in the case of the larger machines, the curve of actual velocities is drawn to suit direct drive off the shaft of such engines as those of Messrs. Willans and Robinson, otherwise velocities 25 per cent. greater would be admissible. It is not desirable to stint the copper, but it should be so disposed that the energy lost is a minimum; for this purpose, on the armature, there should be a few turns of large section, and on the magnets greater length or section, according as they are shunt or series wound. These conditions can, however, only be fulfilled when the iron is also plentiful. If it were not the same quantity of copper might still be employed but with diminished efficiency, and it can only be in special case, where light weight is of greater importance than either efficiency, durability, or cheapness, that little iron can be tolerated.

The load which a dynamo will carry is limited either by such strength of current being attained that any increase would cause a rise of temperature injurious to the insulation of the conductors, or else by the obliquity of the field and self-induction becoming so great as to prevent proper reversal in the sections under commutation. The load is therefore greatly dependent on the relative section of the magnets and armature, and current turns on each, the number of the latter being affected by the resistance of the air space.

In the drum armature the self-induction is least whilst in the ring the ventilation is generally better, the result being that for small machines, electrically, there is little to choose between them, though for these and for high tension machines there are points in the construction of the ring which have special advantages.

In the drum as the coils overlap at the ends, if the insulation of a section fail it is generally necessary to rewind the whole; and also owing to the overlapping there may be great difference of pressure existing between contiguous wires, tending to produce short circuits. In the ring armature, each section is separate, so that short circuits are less easily produced, and repairs more easily effected. For large sizes, however, induction troubles are greater, and as large drum armatures can be wound with a different arrangement of end connections and in a more symmetrical form, by using spiral strips, they are to be preferred. The round conductors are replaced by bars which allow of a larger section of copper, as the insulation takes up less room. It is necessary to make the bars thin on the face in order to prevent undue heating, caused by local currents started in them, between opposite sides as they pass through the unequal field between the polar tips. Frequently, still further to reduce loss from this cause, they are laminated, and a gradual widening of the air space towards the tips of the magnets, by preventing abrupt change in the strength of field is also efficacious in this direction. In a dynamo working with an induction of 12,000 lines to the square centimetre, if the width of a solid bar exceeds a quarter of an inch, with a peripheral velocity of 1,800 ft. per minute, it is difficult to prevent excessive heating from this cause.



$M = \dfrac{\text{Output at 2,900 feet.}}{\text{Iron in magnets.}}$ $A = \dfrac{\text{Output at 29,000 feet.}}{\text{Iron in armature.}}$

$N = \dfrac{\text{Actual speed.}}{\text{Iron in magnets.}}$ $C = \dfrac{\text{Output at 29,000 feet.}}{\text{Copper in magnets.}}$

FIG. 11.—EDISON-HOPKINSON DYNAMO. RATIOS OF OUTPUT TO WEIGHT.

The density of current which can be carried by a conductor varies considerably, according to the intensity of these eddy currents, the conditions of temperature under which the machine is working, length of runs, depth of winding and section and means for ventilation. No general rule can therefore be given, as it may vary from 1 to 2·4 ampères per square millimetre in the magnets, and 2·5 to 6 in the armature, but it is not difficult, from experience in a few cases, to determine the proper size for any particular winding.

In selecting a machine it is always desirable to ascertain what is the rise of temperature to be expected after working. It used not to be uncommon to find machines with armatures which heated to nearly boiling point of water, and though many have lasted for years, there is always a gradual decay of the insulation going on, which together with expansions and contractions of the metal and working strains, finally loosen the conductors in their places. The tendency has been constantly to reduce the temperature, and the Admiralty specification, which is intended to cover the most trying conditions, limits the rise to 40° Fah. Such a low figure, however, entails a very expensive machine, and for general purposes fully double this rise, may be permitted without any risk whatever. Rise of temperature in the armature also has the effect of reducing the pressure, because the co-efficient of resistance of copper increases, so that in a machine in which the current density is high there may be a perceptible difference in the performance after it has had time to warm up, which will necessitate an increase of speed.

The commercial or net efficiency of a dynamo is the ratio of the electrical energy, available for use in the external circuit, to the total mechanical energy absorbed. The difference between the two being made up of losses due to friction, to eddy currents, and to heating of the armature core due to its being magnetised first in one direction and then in the other, together with the further losses due to armature and magnet coil resistances.

The electrical or gross efficiency is the ratio of the power available in the external circuit, to that part of the energy transmitted by the belt which is converted into electrical energy, that is, to the electrical energy in the external circuit plus whatever is lost in overcoming the magnet and armature resistances. In the earlier machines the losses from all these sources, especially from armature resistance, were so high as often to reduce the net efficiency to below 60 per cent. In recent machines it is rare to obtain a return of less than 80 per cent., and in the best machines it amounts to over 90 per cent., sometimes reaching 95 per cent., but small machines, or those run at very slow speeds cannot be expected to give so high a return, as the resistance of the armature conductors will be high. For this reason it is only for the sake of coupling direct to the engine shaft, thereby gaining in compactness and absence of belting, that very slow speeds are much employed. Very high speed, again, possesses the same disadvantages common to its use with other classes of machinery, and a velocity of from 1,800 to 3,000 feet per minute at the periphery of the armature is now commonly adopted.

The mechanical strains which are likely to be injurious are confined to the armature. The chief one is the stress on the conductors, tending to make them slide on the surface of the core. In small machines bands of brass wire wound closely round the circumference produce sufficient adhesion to keep them in place, but in large machines it is desirable to provide a positive means of driving, for which purpose radial metal pegs can be let into the core. A considerable factor of safety is required in all parts of the armature, because accidental short circuits in the external circuit are liable to cause sudden rushes of current, producing enormous transient strains, which may cause the conductors to be displaced, and may permanently strain the shaft. The latter effect is specially liable to occur in machines in which, owing to the shape of the pole pieces, the magnetic attraction of the core is not equally balanced. This is a defect sometimes found with single circuit dynamos in which the section at the extremity of the poles is much reduced by being tapered off. The armature may then be attracted towards the magnets with a pull amounting to many times its own weight, and even under normal conditions of working, this is liable to make the bearings heat. It can, however, be remedied by placing the armature eccentrically in the fields, so that on the side where the pull would be greatest the air space is increased. There may also be end pull if the core projects unequally beyond the bore of the magnets.

The materials at our disposal for insulating purposes are divisible into those which are rigid or flexible, combustible or incombustible, damp or oil-proof or the reverse. All the most useful qualities cannot be combined in one material. For the insulation of the commutator, it is difficult to imagine anything more suitable than mica, its price is, however, too high, and it is not sufficiently flexible to be applicable for all purposes. Fibrous materials, treated with varnish or India-rubber, are almost compulsory for the insulation of the conductors. These will withstand as high a temperature as on other grounds it is at all desirable to permit, and with care and cleanliness may last for years. There is, however, no denying that owing to their yielding and absorbent nature they form the weakest link in the structure, and any small leakage set up is rapidly extended, owing to the charring of the material. Possibly in the future the skill now so abundantly brought to bear on the production of artificial substances will place fresh materials at our disposal.

In general proportion and design the dynamo has arrived at a stage at which little radical change can be expected. The efficiency is already so high that increase is scarcely possible, and, as far as consideration of cost of power is concerned, a differeece of 5 per cent. one way or the other is rarely of much importance, but seeing that a high efficiency is accompanied by a reduction in heating, in sparking, and undue strains generally, it betokens a thoroughly sound and reliable machine, requiring the minimum of attention, and therefore to the purchaser carries with it a warranty of satisfactory performance.

Future improvements will probably chiefly consist in details of construction, labour saving in production, and perhaps new and less perishable materials for insulation. Abolition of the variable sparking point is the most important problem which remains to be solved.

In working it should never be forgotten that though few pieces of machinery, even of simpler construction, requires so little attention, the dynamo will not stand neglect or unskilful handling, and amply repays a moderate amount of care bestowed on it.

I have to express my thanks to Messrs. Mather & Platt for the facilities which they have afforded me at their works for the preparation of this paper.

Institution of Electrical Engineers.

"DISTRIBUTION OF ELECTRICITY."

By MAJOR-GENERAL WEBBER, R.E.

(Abstract of Paper read on January 22nd.)

IN September, 1889, I read a paper before the British Association at Newcastle, on the subject of the "Distribution of Electricity in parts of Chelsea and Kensington, with Accumulators as the main source of Supply."

The adolescence of the system being safely reached, the Institution will be naturally desirous to know if the combination described in 1889 as "Accumulation of the main supply from a generating station in storage stations, situated at suitable distances from one another," is a success.

(*a*) As regards the charging of the accumulators at high pressure, and discharging for distribution at low pressure, and effecting the changes necessary to the same by the special automatic arrangements placed in each storage station. The system designed by Mr. F. King has worked uninterruptedly in each of the four storage stations now in actual use.

The arrangement then described showing three units of generating plant in series, charging one of the half batteries in each of the three storage stations, with a current of 75 ampères and 1,500 volts in the charging mains, in combination with the automatic regulating plant by which the changes of the half batteries in and out charge and discharge are made, have been in daily use.

The mercury cups and contacts have behaved perfectly, and there has been absolute freedom from heating in any of them.

The very small amount of alterations that have been since necessary is a proof of the care with which the Electric Power Storage Company made trial of the regulating apparatus before putting it to work for the Chelsea Company.

(*b*) The supplementing of the main supply by means of continuous current transformers is a portion of the system of which our year's experience has gone far enough to satisfy us that it is an efficient and reliable way of providing for the increase in demands for current which the full discharge of the storage stations would be incapable of meeting; and that the economy arising out of the employment of the generating units, during otherwise idle hours, compensates for the loss in conversion.

Careful tests of the first continuous current transformer designed by Mr. F. King, made last August in the presence of Mr. Raworth, engineer of the Brush Electrical Engineering Company, gave the following results:—

	Primary.		
	Volts.	Amps.	Watts.
No. 1 test	588	64	37,632
No. 2 test	606	72·5	43,935
No. 3 test	604	72·5	43,790

	Secondary.			Efficiency.
	Volts.	Amps.	Watts.	Per cent.
No. 1 test	110·5	280	30,940	82
No. 2 test	111·5	327	36,460	82·9
No. 3 test	111·5	320	35,680	81

The total weight of the machine is 4 tons 7 cwt. 2 qrs.

The field magnet armature and shaft are carried on a cast-iron bed and pedestal, having an over-all length of about 6 feet, and a height of about 3 feet 6 inches.

The armature is ring type, carried by a 3½-inch shaft, having two commutators, one at each end. The primary circuit, or motor, commutator has 72 sections; that for the secondary generation has half that number, namely, 36.

The primary circuit on the armature consists of 72 segments, ·120 inch diameter copper well insulated wire, corresponding to the number of commutator sections, having a conductivity resistance, measured at opposite segments of ·1755 ohm.

The conductor forming each section is wound in an ebonite channel laid between the copper strips which form the secondary, or generator circuit, and arranged in a single on the outside, and a double layer on the inside.

The secondary or generator circuit is composed of copper strip of ·0593 of an inch sectional area, in 36 coils, each of which is connected with a section of the right-hand commutator. The conductivity resistance is ·0087 of an ohm.

The core of the armature is composed of charcoal iron rings ·022 inch thick, insulated from each other, the external diameter of which is 17½ inches, and inside 8½ inches.

The weight of the iron in the field magnets is 2 tons 11 cwt. 2 qrs. They are wound with ·095-inch copper well insulated wire in 20 layers, having 2,720 turns on each limb, and have a conductivity resistance of 18·9 ohms, being connected in parallel with the discharging mains.

The behaviour of this machine, both as regards heating and sparking, has been throughout all that can be desired, and as the type improves, we expect an improvement in efficiency.

Mr. King has favoured me with the following remarks:—

"The peculiar advantages of the combination of transformer and battery circuit which is at work at Chelsea, are the ability to, at all times, use the transformer to its fullest capacity, and therefore greatest efficiency both in engine, dynamo, and transformer; and the absolute regularity with which the potential at the secondary, or generator, terminals of the transformer will follow the varying potential at the junction with the feeders to the distributing main.

"It is, of course, easy to see the reason why the machine behaves in the matter indicated. Any fall in the potential of the discharging mains means a reduction in the intensity of the magnetic field in which the armature rotates, and with a constant motor current this reduction of magnetic field means an increase of speed, until the number of revolutions is sufficient to raise the E.M.F. in those mains so as to react on the fields.

"The action of the machine, therefore, is consequent on the intensity of the magnetic field, created by the E.M.F. existing at any moment on the discharge mains, and the strength or current in the primary circuit, which will cause variation in speed sufficient always to produce at the secondary armature an E.M.F. equal to that of the discharge at the station."

THE PARKER (WOLVERHAMPTON) C.C. TRANSFORMER.—The tests of the manufacturers, which have not yet been verified by us with working loads and long continuous runs, show that:—

1st. With an output of 1,600 watts, the efficiency is 81½ per cent.
2nd. With 20,000 watts, it reaches 89½ per cent.
3rd. At 40,000 watts, it attains 92 per cent.

The weight of the machine is 5 tons, and the floor space required for it is 7 feet by 3 feet.

The armature is of the drum type. The primary is wound with 200 turns connected up to a commutator with 100 bars. The secondary has 80 turns connected to 40 bars in the commutator at the opposite end. The diameter of the core is 14 and $\frac{15}{16}$ths inches, and of the finished armature 16 inches. Its length is 22 inches. The winding of the primary is for 540 volts and 75 ampères, and of the secondary 108 volts and 350 ampères, with a speed of 550 revolutions; the resistances of the primary and secondary and of the magnet, respectively, being ·17, ·001, and 8 ohms.

LAURENCE SCOTT'S 40-UNIT C.C. TRANSFORMER.—The following description of it has been given me by the makers:—The conductors on the armature are laid in deep and narrow slots milled in the iron plates comprising the core; the low-tension conductor, which is of copper strip, being disposed in the bottom of the slots, with the high tension, of fine stranded cable, above. There are 88 of these slots, each 1·8 inches deep and ·22 of an inch wide; one of the low and five of the high tension conductors being in each slot. The mechanical advantage of this arrangement is that it is impossible for the conductors to slip over one another to the smallest extent. There are 44 sections in each commutator, the low tension having one turn per section, and the high-tension five turns.

Ventilation is secured by hollow spaces left between the shaft and each commutator, extending along the shaft to each end of the core, where ½-inch spaces are left, extending to the outside of the armature. The high and low tension circuits are insulated from one another, and from the armature core, by mica everywhere, except at the vertical ends; and as an additional precaution against the one breaking into the other, caps of brass wire gauze in electrical connection with the shaft, but carefully insulated from the conductors, are arranged between the two windings at the ends, so that before the high could break into the low tension circuit at either end of the armature, it must come into contact with one of these caps, and therefore with the frame of the machine. In the core itself, the iron plates effect the same object as these caps, as they are purposely put in electrical contact with the shaft.

The weight of the whole machine is 65 cwt., and speed 660.

Current-density in high-tension winding with 375 amperes = 2,450 ampères per square inch.

Current-density in low-tension winding with 75 ampères = 2,080 ampères per square inch.

Loss in high-tension winding, hot = 1,425 watts.
„ low „ „ „ = 945 „
„ field magnets ... ... = 402 „
Current in „ ... ... 3·7 ampères.
Electrical efficiency ... ... = 93·7 per cent.

Of the endurance or efficiency of this machine I am not as yet in a position to give results.

Of the efficiency of the service to the public in the Chelsea Company's district there has been ample evidence in the contents of a long list of testimonials from customers, which without exception are unanimous in praising the constancy, regularity, and perfect steadiness of the supply.

This variation in the anticipated demand has been marked by its inequality in various parts of the same district. Thus, in one of the new residential gardens in the Chelsea district the custom on one side is rather above the average, whereas on the other side—consisting of 15 or 20 houses of an average rental of £400 a year, in front of which mains have been lying ready to supply for more than a year—as yet, in only one is current being supplied.

To provide for such contingencies as this in the first instance, would have entailed a first outlay in insulated copper, and a consequent idleness of capital, which prudence forbade. In some cases the growth of demand at certain spots overtook the means of supply, with a temporary sacrifice of maintenance of the full mean statutory pressure.

The Chelsea system having started before most others, special experimental Board of Trade rules had to be summarily compiled, and these were more or less on their trial. The authorised rules, which dealt in an important way with the question of constant pressure, were only issued in November last.

As regards the efficiency of the generating plant, I will remind my hearers that the unit of power is one Willans and Robinson G.G. engine, geared direct to a 40 to 42 unit dynamo, which, running at its normal speed, can yield 70 to 75 ampères at 500 to 550 volts. This plant, when in full use, is run charging a distant storage station from midnight to 3 p.m.; and from 4 p.m. to 11 p.m. It runs, by means of the same charging mains, a C.C. transformer (already described) placed at the same point.

In practice, the yield in the first period is—

38 units during 14 hours = 532 units.

In the second period—

44 units during 7 hours = 308 „

Total in the 24 hours = 840 „

The tests of our Babcock and Wilcox boilers show an efficiency of 10·2 lbs. of water per lb. of combustible (ash and firing up being deducted); and also that it has required 5·74 lbs. of combustible to produce each unit at the terminals of the dynamo.

This corresponds to 3·64 lbs. per I.H.P.—a figure which we are in process of reducing, and expect to reduce to 2·7 lbs.

The average loss in the charging mains, and by conversion with the two means in use, is just 20 per cent., and in the distribution between the converting stations, or sources of supply, and the consumers' terminals is 2 per cent. The 43 cwt. of coal used in the generating stations to produce 840 units delivers 690 units into the company's meters, or, as nearly as possible, 7 lbs. of combustible per unit of electricity sold, which, at 25s. a ton, is less than ·94 of a penny, but which I prefer to take at one penny, per unit, for fuel.

The accumulators in our storage stations have now been in use for periods varying from 21 months to nine months.

After 18 months' full use, it was found, from tests made by the manufacturers, that one-third of the active material of the positive plates had been exhausted. During the latter six months of the same period—which may be considered a good example of normal rate of waste—the peroxide which has scaled off and fallen to the bottom of the glass cell and been removed has averaged half a pound per month from 15 plates, or half an ounce per plate.

The general conclusion come to is, that under the normal circumstances of charge and discharge of the Chelsea system the life of the brown plates can be calculated at three years at least.

In a district like the north-east of the parish of Chelsea the average number of residences or shops within the area of a square of 175 yards a side is 93, and assuming that our experience is correct—namely, that each will use on an average a maximum of 28 8-candle-power, or 35-watt, lamps at one time—then the total number will be 2,500, and the current with a pressure of 100 volts required will be 880 ampères. It is safer, however to allow 10 ampères per house, which would require 930, or a section of copper in all the distributing mains, leaving the station of 2 inches, at 1,000 ampères to the inch. In like manner, each pair of stems which conduct the current to the base of a "tree" covering a similar area will together have a section of 2 inches, assuming that the generating units deliver current at a higher pressure between the terminals, for the more distant areas.

As regards the economical aspect of the use of insulated conductors, practice shows, in any comparison, that where a small section of copper in each conductor in the same line only is required, other conditions being alike, it is much cheaper to use insulation of the character of bituminous compound, in ducts or "ways," of a small size and economical material, than to look for insulation to non-conducting supporting surfaces, with a large surrounding of air space subsisting in a subway of which the minimum first cost must be represented by a substantial figure.

It is in connection with large mains that the engineer who has first adopted the use of a dielectric material to surround his copper first turns his attention to bare copper, with a view to obtain a saving in construction. The size of these mains is controlled by the distance between the points of source of supply for a given demand in a given area.

Obviously, if these points can be placed nearer or farther apart, according to what may be called the density of demand, there can be found a fairly definite limit to the size of the largest mains.

The positions of the feeding points in the areas between the points of source of supply are so much governed by conditions connected with the routes and communications of streets, that their theoretical frequency can rarely be maintained. In this respect only, then, apart from localisation of demand, need there be any uncertainty as to their size.

But where the source of supply is a large generating station, distributing at low pressure direct into a network of mains over a large area, say three-quarters of a mile a side, then I regard the adoption of a system of underground construction, such as that known as Mr. Crompton's, and used in part of Kensington, as unavoidable, owing to the necessity of using stems or feeders of large capacity. Indeed, such a system is the natural outcome of the conditions under which running machinery is the primary, and accumulation is the secondary, source of supply, with low-pressure distribution from one source.

On the other hand, when these conditions are reversed, the proximity of the sources of supply reduces the section of copper required for feeding the distributing network, and, as I have said, the cost of the underground works is by its simplification much reduced. Also, the position of the generating station is a matter of comparative indifference.

Accumulators used in connection with any system which virtually distributes direct from the dynamo at low pressure can be regarded only in the light of auxiliaries, and in no sense as a main source of supply, or even as a stand-by. So far as I have observed, they act as little more than regulators, and are generally charged and discharged at the same time, and therefore not really fairly treated, and cannot be expected to have an average life.

I am led at this stage to refer to the question of the candle-power of the lamp, to which supply companies refer when they give a popular estimate of the work they are doing. We hear of companies supplying 45,000 lamps, and others 100,000, and so on. Now, the question is, What do they mean?

Not long ago a "glow lamp" meant a 16 or 17 candle-power lamp, consuming 60 watts per hour. If a calculation is based on such a unit, it is certainly not one that exaggerates the position of the suppliers.

Most engineers, if they thought in numbers of lamps at all, meant 10 to the nominal H.P.

Now, I wish this meeting to understand that from the first I have been one of the few that have steadfastly opposed the 60-watt lamp being the standard, for several reasons.

In Chelsea we have from the first endeavoured, in the true interests, I believe, of an eventual large general consumption, to use the 8-candle lamp as our standard. In all circulars issued to the inhabitants and to customers we have consistently urged the use of that candle-power only, and the expediency, when more light is wanted at one point, of having rather two 8-candle-power than one 16-candle-power. We have pointed out over and over again that even in the largest houses, if there are no 16-candle-power lamps existent, their want is never felt, and the multiplication of 8-candle-power at each point is far the best way of illuminating.

At the risk of having the appearance of an endeavour to multiply numbers, all reports and publications of the Chelsea Company since 1885 have spoken of 8 to 10 candle-power lamps as the standard; and I believe that by degrees this policy—the wisdom of which cannot, I submit, be doubted—is having its effect, and that grumblers at the cost of the light who began, in spite of our remonstrances, by using 16-candle-power lamps, are gradually adopting eights.

Any of my audience can have a practical example of the truth of what I say by visiting in succession Brooks's and the Devonshire Clubs, which are almost next door to one another. In Brooks's there are not half a dozen 16 candle-power lamps; in the Devonshire, I believe, there is not one 8-candle-power; and yet I defy any unskilled person to detect the difference without being led to observe it by being previously warned of its existence.

If a glow lamp is properly used, and placed so that the filament cannot be seen in all its naked dazzlement (so to speak) by the eye, 8 to 10 candles, or a 35-watt lamp, is amply sufficient at each point where light is required, under almost every circumstance of the needs of daily life.

While on this subject, I would remind the supply companies of the very hard facts that no assertions of theirs about their "custom" can refute, and these are, that candles and lamps in private houses, and gas in shops, are being proved to be much more serious rivals than they first pretended to allow. I think we may have our own selves to thank for some of this, because we have encouraged an unwise and wasteful application of our illuminant, and made it come out more costly than it need.

In the case of shops we have erred still more. We have overlooked the reasons for the successful rivalry of the Wenham and Sugg gas burners, and, instead of showing how electric light can be used more easily than other means for illuminating the tradesmen's wares, we have followed the lead with a poor imitation of gas, which obscures the vision of the passer-by, and makes it impossible to examine the details of the articles exposed. I have studied this question in our own and foreign streets, and am convinced that, in the long run, electric lighting will suffer, for the reason that, whatever its advocates may now say, a large number of tradespeople who are now employing it, after a trial of its use and cost, will return to that of gas.

The future and ultimate demand in any locality is one of the most difficult problems that the engineer has to face.

In Chelsea we have come to the conclusion that out of five lamps installed in private houses two represent the maximum number in use at one time, and that we cannot expect that the gross earnings of each lamp installed will exceed 8s. 6d.; with the added fact that 70 is the average number of lights installed in private residences. This gives 28 in use at one time, at a cost of a little under £30 per annum at 8d. a unit.

I know that this compares unfavourably with such districts as St. James's; but Chelsea is an average residential district, and St. James's is simply the cream of the world.

In the districts in Chelsea and Kensington originally allotted to the Chelsea Company the total number of houses in the streets and squares within the areas of supply is 1,258. This number includes all shops and residences, except those in quite the smallest streets. In this area the ultimate possible demand might be for 86,000 8-candle-power glow lamps installed, two-fifths of which—34,400—will probably be the maximum in use at one time.

At present, of these houses 252 take current, in which actually the equivalent of 20,000 8-candle-power lamps are installed, and of which the maximum of about 8,000 are in use at one time.

There are at present in the district four sources of supply, and 17 intermediate points where a constant pressure is maintained.

The area within the parish of Chelsea which has been last added, and which contains no compulsory or scheduled streets, circumstanced as follows:—The number of houses is approximately 4,400. The probable custom is likely for a long time to be confined to favoured spots, in which the ultimate demand will be 230 houses, having 18,400 lamps installed. The ultimate possible demand in this latter area cannot be estimated until a large portion of it is rebuilt.

Experience is showing that occupiers who take the light do so either as a genuine luxury and convenience, for which it is well worth paying, or else to follow a fashion. After those have come in, they are followed by the "hesitators;" then there is a lull; and, finally, the conditions which originally deterred the majority make them hold off for a very long time. After that, the accessions will only occur when changes of occupation, and other infrequent events, take place.

It would be to the advantage of the supply companies if electricity could be called the poor man's light. But when you consider that the cost to the company, together with that to the customer, of joining up a house, including the meter and safety apparatus, is, on an average, not less than £12, it is clear that even the £50 occupier is still a good way off from electric light for domestic purposes.

To meet one-third of that total possible demand, the central station will shortly contain seven 75-H.P. units of power to charge the five distant sources of supply, and drive one transformer motor at each, with three 105-H.P. units to generate directly at low tension, and charge the storage reserve in the station when required to do so.

Without going into financial details, it is easily seen how the gross earning capabilities of the station and surrounding system of supply and distribution in its present state will exceed £13,000 a year when one-third the houses in the first area take current. How much of this may be expected to go to make up the net earnings is a matter I, for the present, may be allowed to forbear to suggest.

A condition of the Chelsea system is the means of maintaining approximate constancy of pressure throughout a network system of distribution. It has, with slight variation of values, been maintained in full work at each of our storage stations since April, 1889.

The system of underground work used is the one known as the Callender-Webber system, in which the cables can be drawn out without disturbing the ground.

The network laid down in this system is situated along one or both sides of 41 streets, squares, and gardens of Chelsea and Kensington. The total length, in yards, of line of route followed is 9,520—nearly 5½ miles.

The total length of insulated copper cable, varying between 61/12 and 19/15, in use for distribution of current is 27½ miles.

Besides the above, there are 1½ miles of pilot wires, making a total of conductors of 29 miles.

And the total weight of copper actually under the ground and in use is 51½ tons.

As compared with the Crompton system we have the following result of observation:—

Generally speaking, if the section of copper in a pair of conductors is 1 inch and under, then a main constructed with insulated cables in separate "ways" is cheapest—increasingly so with small conductors. Between 1 inch and 1½ inches the comparison varies according to circumstances. Over 1½ inches of section, then uninsulated copper in conduits bears away the prize for economy.

Actual experience in Chelsea enables me to give an example of the actual cost of a three-2-inch-way line laid in one of the squares.

Its length is 613 yards. The cost of supplying and laying the casing, including vestry charges and an allowance for engineering profit, was at the rate of 6s. 6d. a yard.

For purposes of comparison, the cost of the surface boxes must be added to the above. Allowing draw-boxes for large angle changes of direction, and one service box for every two houses, we must add 2s. 3d. per yard, or a total of 8s. 9d. per yard,

On the three-wire system—for which provision is, I believe, always made in Mr. Crompton's mains—the three ways in the above example can receive two bitumen high insulation cables of 61/12, having an external diameter of 1·71 of an inch, and one 61/15, with an external diameter of 1·40 of an inch.

The section of copper in these three cables is 1·335 of an inch, and their cost per yard *in situ* is 31s. per yard, giving a total cost of the completed line at less than £2 per yard.

This line is sufficient to convey current to all the 60 houses which are situated along the route.

If provision need be made for half the houses only, then the cables will cost 18s. a yard, or at a total of 25s. 9d. for the main per yard.

In actual practice 324 yards is an unusual length for a distributing main, and the ends of the stems being nearer to one another, the section of copper may be less.

Supposing that the space between the stones of the footway and the cellars of the houses did permit of the introduction of culverts for the passage and insulation of bare copper—which, as it happens, they do not—even then the cost of the mains must be less per yard than if constructed on the bare copper system.

As regards the question of depreciation, the London Chamber of Commerce has rather startled us by issuing a circular, in which it lays down the rule that depreciation for mains with "bare conductors insulated by means of glass, porcelain, or other such like imperishable materials," may be calculated at 1 per cent.; while that on "all cables or other conductors covered with continuous insulation should be calculated at 5 per cent.

Now, if that body had accompanied their statement by a few words of explanation as to whether the calculation is to be on the cost only of copper insulated in the one way or the other, we might have thought it worth while to discuss with them the question, even though it is quite outside their province to lay down any such laws. But as we are left to suppose that the cost of the whole structure of the main may be included in the figure from which the percentages are to be deducted, I really do not think it worth while to take up the time of the meeting beyond drawing marked attention to the document, which probably several present have seen, in the hope that some speaker, struck with the adventurous nature of the statement, as I have been, may be led to give an opinion on it in the discussion which I hope may follow.

ELECTRIC MINING MACHINERY.

The President of the Institution of Civil Engineers, when moving a vote of thanks to the authors of the paper read on Tuesday last, well said that the application of electricity to mining operations fully deserves the attention of civil engineers, since it had been shown that the efficiency of an electric plant may be as high as 50 or even 75 per cent., whereas its rival, compressed air, cannot show returns of more than from 25 to 45 per cent. under similar circumstances. The advantages of electricity for mining purposes have often been discussed at various mining institutes, as also in the technical press; it was, therefore, most appropriate that the Institution of Civil Engineers should invite Messrs. L. B. and C. W. Atkinson to relate their personal experiences at Great George Street, Westminster. The authors, we are pleased to note, have confined themselves to hard facts, and gave descriptions of machinery constructed by Messrs. W. T. Goolden & Co., who have by this time acquired considerable skill in this branch of electrical engineering, the text of the paper having special reference to the application of electricity to coal cutting, pumping, and rock drilling. Messrs. Goolden & Co. prefer to use three-throw pumps for draining work, the reason being that the load should be as regular as possible throughout the revolution of the motor armature. The pumps and motor are mounted upon the same bed plate, the motion of the armature being communicated to the crankshaft by means of spur gearing, which, although noisy, gives satisfaction, and is preferred to belts as used by Mr. Frank Brain, the well-known pioneer in the application of electricity in mining work. The motor especially designed for this kind of duty has already been described and illustrated in our issue of the 23rd of last month, we need, therefore, only refer to such points which Messrs. Atkinson brought prominently forward in their practical paper. In the case of a coal cutting plant, Messrs. Goolden experienced difficulties of a two-fold nature, viz., electrical and mechanical. In one case they used a 6 H.P. electric motor, driven by a dynamo having a normal output of 10 H.P. The distance between the motor and generator was one mile. Originally, both the motor and dynamo were compound wound, the series coils on the motor consisting of sufficient turns of thick wire to nearly saturate the magnets with the large current developed on first closing the switch; but when running at a normal load, this series coil had little influence on the magnetisation, which was then affected by the shunt windings; so that the regulation as to speed was nearly as good as if the winding had been simply shunt. This arrangement was found convenient for giving a good starting power, and at the same time to ensure satisfactory speed regulation; but in the case of coal cutting machines, the authors express a decided preference for a series wound dynamo and a series wound motor for obvious reasons; when the motor is being stopped, by the insertion of a proper resistance in the circuit, the electromotive force may be reduced to zero before breaking the circuit; and further, if it is desired to handle the cables or disconnect them, or to handle any part of the circuit of the machine after it is stopped, there is no liability to a shock should the insulation at any other point be defective.

The chief mechanical problem in connection with these coal cutting machines has been the best form of cutter bars and cutter, and the best form of gearing to use. As to gear, the authors have tried chains of every description but had to abandon them all, and they have finally adopted cast steel double helical wheels, shrouded nearly to the pitch line. The form of cutter most usually adopted in coal cutting machines is that of a large disc or wheel with the tools fixed into its periphery; the authors, however, have departed from this practice and adopted a bar cutter designed by Mr. Goolden, and they give a number of substantial reasons for their preference. This cutter consists of a long bar, either taper or parallel, fitted with a coupling to unite it to the shaft of the machine, and having arranged on it a series of steel tools. The bar, revolving on its axis, acts like a milling tool, each set of cutters sawing its way through the material. The average length that can be cut without changing the bar for inserting new cutters, may be taken in hard coal to be about 40 yards, though as much as 80 yards have been effected without stoppage. The amount cut by the machine varies according to the nature of the seam, and the experience of the men working it; but it may be taken that on the average, all stoppages being included, 20 to 30 square yards per hour may be cut in fairly hard coal. The actual H.P. developed by the motor varied in different cases from 6 H.P. to nearly 15 H.P., but in the authors' opinion 10 to 12 H.P. would seem to be a fair average for working effectively.

Rock drilling machines, rotary and percussive, have been designed and made by the authors. The rotary drill, complete with its own electric motors, is mounted upon trolley wheels, applicable for coal or ironstone boring. The motor of $\frac{3}{4}$ H.P. runs at 1,600 revolutions per minute, and is connected through bevelled gear and worm gear to the drill spindle which runs at 50 revolutions. It will drill in slate at the rate of about 3 inches per minute. The drill takes about 10 ampères of current at a pressure of 110 volts. Experiments have shown that the ratio between the actual power on the drill shaft and the electrical power applied is about 40 per cent.

For dealing with hard rock percussive rock drills are generally used, but the application of electricity to these, has so far, been limited, one of the chief difficulties being the construction of a really suitable percussive action driven by a rotary motion.

These are the main features of an interesting paper; the discussion which is to be opened next Tuesday will doubtless bring forth the experiences of other workers in the field, and we hope to hear something from our American friends who have had an immeasurably wider practice in matters appertaining to mining with electric motors than anyone in this country.

The Electric Light at Portsmouth.—The installation at the New Town Hall has proved a great success, and the lighting of the grand hall, which is being frequently used for balls and concerts, is the theme for general admiration. With the view of a general introduction of the illuminant into the borough the special electric lighting committee of the Town Council have decided to consult Mr. Shoolbred.

NOTES.

The Electric Light at Durham Cathedral.—During the present week a series of experiments have been made in connection with the lighting of the cathedral by electricity, and which, we understand, were thoroughly satisfactory. On Tuesday, Messrs. E. Scott and Mountain, of Newcastle, erected what is known as a trial installation for the Dean and Chapter, and on the evening of that day, and also on Wednesday, the choir was illuminated with 48 16-candle-power incandescent lamps, 12 being affixed to each of the choir candelabra, and 12 to each of the gas standards within the altar rails. The illumination, as previously stated, was very satisfactory, the light being far superior to that afforded by the present gas lighting arrangements. One of Messrs. Scott and Mountain's Tyne compound-wound dynamos, driven by a small vertical steam engine, was placed in the stone yard, and the current conveyed by means of cables to the fittings mentioned, in the choir. The installation was witnessed by Canon Tristram, Archdeacon Hamilton, Dr. Greenwell, Dr. Armes and several others. We understand that it is proposed to extend the electric light throughout the entire Cathedral, the present experiments being for the purpose of determining the actual quantity of light required and the best arrangement of the lamps. If the results are deemed satisfactory, the Dean and Chapter will proceed with the scheme of lighting the Cathedral by electricity. In the event of the idea which has been proposed being adopted, the Wear will be utilised to work the turbines, which will provide the necessary power not only for lighting the Cathedral, but also the residences in the College, and it is proposed to put in accumulators of ample capacity to supply the current to the Cathedral and to the houses. This would provide a perfect safeguard against any possible failure in the light. In addition to this, the scheme provides a dynamo of sufficient power to run the whole of the lights, so that under ordinary circumstances the accumulators would not be required. But the proposal is to charge the accumulators during the day and utilise the stored current for the Cathedral services and the residences in the evening. It is proposed to light the nave by five candelabra similar to those in the choir, each of which will have 20 lights. Each transept will be similarly lighted.

Ship Lighting.—The ss. *State af California*, launched by Messrs. A. Stephen & Sons, Linthouse, Glasgow, on 29th ult., is being fitted throughout with the electric light. The installation, which is being carried out by the Woodside Electric Company, Glasgow, consists of about 330 incandescent lamps each of 16 C.P. There is a duplicate set of machinery—two Chandler double-cylinder engines coupled direct to two "Woodside" compound dynamos—and each set is capable of supplying the whole number of lights. The wiring is on the single wire system, the necessary precautions being taken to prevent derangement or the compasses by the electric current. High insulation vulcanised rubber covered wires and cables sheathed with lead, and run in grooved casings, are used throughout. The light is carried throughout the whole ship wherever light is required—steerages, holds, hatches, and signal lights, as well as the engine room, officers' quarters, and passenger accommodation. Each steerage and hold is lighted from an independent circuit, and the fittings in these places are made removable so that they can be taken away when the spaces are required for cargo and replaced if steerage passengers are to be carried. The fittings in the saloons, music room, smoking room, entrances, &c., are of special designs harmonising with the general fittings of the ship, they are electro-silver plated and fitted with richly cut crystal globes. A similar installation, consisting of about 230 lamps, with duplicate directly coupled machinery, is being fitted by the same firm on the ss. *State of Nebraska*.

The Electric Light at Bath.—Prof. Forbes has been instructed by the Corporation to make an inspection of the electric light works in Bath. He has been asked not only to give a general report but to report upon certain specific points upon which it was desired to have his opinion.

Bradford Electric Lighting.—What may be termed the last step in the provision of a continuous day and night supply of electric light by the Corporation of Bradford, was completed last week by the introduction of 65 Crompton-Howell secondary batteries. It has been found an expensive arrangement to keep an engine and dynamo running when the use of light was at a minimum, and these cells are intended to meet the needs of the users of the light between midnight and twilight. The accumulators will be able to supply 2,000 lamps of 16 candle-power each for one hour. There has been added to the plant at the works a Willans three-crank compound engine of 300 indicated horse-power, and working at the high steam pressure of 140 lbs. to the square inch. This engine drives a dynamo capable of supplying 2,500 lamps of 16 candle-power each. The dynamo is by Siemens Bros. & Co., Ltd. It is the largest of its class turned out by that firm, and is allowed to be the finest machine they have made. The total horse-power represented now at the station is about 800, there being, in addition to the engine in question, three of about 150 indicated horse-power each. Since the beginning of November three new feeding mains have been put down in the town. What has been said will be sufficient to show the rapidity with which the electric light is gaining favour in Bradford, but perhaps the best way of indicating the growth of the installation will be to say that when the works were opened in September, 1889, there were connected with them lamps of a total power equal to 8,000 candles only, whilst there are now lamps supplied representing 120,000 candle-power.

The Unfortunate Electric Light.—On the occasion of a banquet given by the Marquis of Bute, on Wednesday night, the usual gas jets were augmented by the electric light. Incandescent lamps were placed in Chinese lanterns, and distributed amongst the festoons of evergreens. Towards the close of the evening the assembled guests were alarmed by an outbreak of fire amongst the decorations; the flames rapidly spread and the roof was soon alight; fortunately, however, the efforts of the borough brigade speedily subdued the fire, though not until extensive damage had been caused. Had there been no electric lamps used everyone would have been satisfied that it was a downright honest fire, but the report soon spread that electricity was the perpetrator of the evil deed, and the *Times*, in its issue of yesterday, fixed its seal of authority to this statement. On making enquiries in Cardiff, we are informed that the fire was certainly not caused by electricity—there was absolute proof to the contrary. A large number of gas jets were burning, which were also surrounded by paper decorations.

The Gaiety Theatre, Glasgow.—This theatre which has been taken over by Messrs. Moss and Thornton, the well-known caterers of music hall entertainments, has undergone a thorough reconstruction. The whole building is lighted by electricity and includes about 300 lamps. Messrs. King, Brown and Company were the contractors.

Cause of Fire Unknown.—On Wednesday morning, part of the covering of electric light leads in Arthur and Company's warehouse, Glasgow, took fire from a cause at present unknown. The firemen were called, but their services were fortunately dispensed with.

"Electricity."—The editor of *Electricity* is famous as a joint author; he has now immortalised himself over Elmore copper. But his knowledge of things electrical seems to be on a par with his journalistic experience, for commenting on "Our patent list," which he started in the last number of his pennyworth, he says: "None of the other technical papers, as far as we know, contains this information," but then, of course, he cannot be expected to be yet acquainted with the efforts of his older contemporaries to supply "this information" We would, whilst on this topic, politely suggest that the proofs of the articles appearing in *Electricity* should be read before reaching the public; slips will naturally occur, however careful one may be, but 30 misprints and mistakes in two columns become irritating to the reader.

Electric Lighting of the St. James's Theatre.—This theatre is now lighted by the electric light, which was used for the first time on Saturday last, when "Sunlight and Shadow" was put on the boards. Messrs. Rashleigh Phipps and Dawson carried out the installation, completing everything within four weeks.

The Cost of Elmore Copper.—In a long article on last week's visit to the Elmore Copper Depositing Works *Engineering* says:—"In our former article we calculated that, taking the Lancashire standard of one penny per hour as the cost per horse-power of rent and power, it would follow that copper could be deposited at a cost for these two items of ½d. per pound. We have since seen some calculations made by Dr. Hopkinson, in which the same result is reached." Now, if our contemporary and Dr. Hopkinson meant anything at all, they intended to convey the impression that this applied to the Elmore process. If we make a calculation on what was seen in operation, we find that to produce 5 tons of tubes some 75 H.P. had to be developed during a week of 168 hours. Taking the "Lancashire standard" of one penny per hour as the cost of horse-power and rent alone, this totals up into the respectable sum of £52 10s., or 10 guineas per ton of copper above the cost of raw material, leaving out of consideration every other expenditure. This in itself is double the sum estimated by Dr. Hopkinson, and that gentleman ought really to explain how he arrived at his extraordinary result. The accuracy of our strictures on this process must be gradually becoming more and more apparent to the minds of everybody, excepting perhaps to that of Mr. Stepney Rawson.

Electric Light in the Holy Land.—A decided sensation has been caused in Jerusalem by the introduction of electric light into a new and flourishing flour mill lately started there. The proprietors, who are Germans, are to be congratulated on this new development. The building in which the light has been introduced, is near to the supposed site of Calvary, and close to the Damascus Gate. It need hardly be said that the Arabs and Jews are much puzzled to account for a light in a lamp in which there is no oil; and up to the present time, while gazing with wonder, have been keeping at a respectful distance.

The Westinghouse Crisis.—Of all the light companies conducting business in Pittsburg that are spoken of as Westinghouse concerns, only the Electric Company is in financial trouble. There is, however, no connection between these companies, except by the ownership by Mr. Westinghouse of a large interest in the stock of each, and of the fact that he is president of seven of them. All the capital the Electric Company requires can be secured by the placing of from 30,000 to 40,000 shares of the par value of $50 each of its preferred stock, either for cash or in settlement of outstanding obligations. Mr. Westinghouse is now devoting himself to the placing of this stock, and is very hopeful of success. It is believed that the confidence of the public in the integrity of a corporation that has undoubtedly transacted an enormous and profitable business will remain, even in the present crisis, firm enough to secure its ultimate extrication from its unfortunate position.

Another account says:—The Advisary Board appointed by the bankers and business men of Pittsburg to look into the Westinghouse interests, and consider the advisability of loaning the various concerns in need of assistance $500,000 to carry them through their present financial difficulties, has decided against the proposal, and financiers and stockholders now favour the appointment of a receiver for the Westinghouse Electric Company. Two reasons weighed chiefly with the advisary committee, one being that the resolution under which it is acting entailed upon it the arrangement for the extension of all the claims of general creditors, which would lead to weeks of hard work, and for which the members did not have time; the reason was that the committee could not use the money without practically assuming the direction of the business of the company, which it did not care to do.

Electrical Standards Committee.—The second meeting was held at the Board of Trade on Saturday last, the following members being present:—Mr. Courtenay Boyle, Major Cardew, Mr. Preece, F.R.S., Mr. Graves, Lord Rayleigh, F.R.S., Sir William Thomson, F.R.S., Prof. Carey Foster, F.R.S., and Dr. Hopkinson, F.R.S.

Electricity at Folkestone.—Mr. Councillor Logan has given notice that at the next meeting of the corporation of Folkestone he will revive the question of lighting the town streets with electricity.

Lighting of Erith.—The Erith Local Board have appointed a committee to consider the question of the future lighting of the area over which they have control, and as both gas and oil lighting have been tried and voted failures in this locality, special consideration will be given to the desirability of adopting the electric light.

Chatham Provisional Order.—In consideration of the company having already spent £10,000 in supplying the electric light, the Chatham Local Board of Health have resolved to recommend the Board of Trade to accede to an application of the Chatham, Rochester, &c., Electric Lighting Company to be released from the engagement of depositing £500 as a guarantee for the fulfilment of the provisional order.

Opposition to Bromley Provisional Order.—The South-Eastern Railway Company have notified their intention of opposing in the House of Parliament the provisional order passed by the Board of Trade on the application of the Bromley Local Board for electric lighting powers.

A Correction.—Mr. Richards writes to us as follows:—I have discovered, on comparing my rough notes with the article on Photometric Research, which appears in the last issue of this journal, that I have omitted to complete a paragraph (viz., col. 1, page 147), which should read thus:—"Before closing the strictly physiological section, it may be well to state that the contraction of the iris is governed by the resultant 'optical exhaustion,' and that this again is dependent to a certain extent on the action of light upon the individual and separate rods composing Jacob's membrane; for if the brilliance of a small spot of light be so great as to endanger only a slight number of these exceedingly minute organs, the pupil will at once contract." As the omission of these few words may lead to misconception of the manner in which the iris is caused to act, under the circumstances detailed in the illustration of the illuminated circular surface (page 46, and other portions), and therefore to criticism, I have thought it advisable to pen these few lines. Two other portions I have noticed (on page 147) should read: "But he feels confident that *a* no greater percentage of light than 30 per cent. is lost after the partly double reflection, *as* against, &c.;" also, "If two circular beams be considered, one having, &c."

The Institution of Electrical Engineers. — On Thursday, at the ordinary general meeting, there will be a discussion on the paper read by Major-General Webber, "The Distribution of Electricity, with Especial Reference to the Chelsea System."

The Secretary says:—The annual general meeting of the students of the institution will be held at the offices of the institution on Friday, February 13th, at 8 p.m., to elect the secretary and committee for the present year. All students are earnestly requested to attend.

Private Installation.—We are informed that Mr. Campbell Swinton is carrying out an installation of electric lighting at Sunningdale Park, near Ascot, the residence of Major Joicey.

Musical Telegraph Clerks.—During the progress of affairs at the Central Telegraph Department in 1890, not the least important and praiseworthy event was the formation of the musical association known as the "St. Cecilia Orchestral Society." It is surprising that such a step was not taken long ago, especially when the great and ever-increasing number of the staff is considered; but it was not until 21 years after, what is known as the "Transfer," took place, that the project, though often mooted, assumed practical form. After the inharmonious "whurr" of motors, transmitters and receivers, the rattle of keys, and the uncertain rythm of sounders, bells and perforators, it must be with a sense of profound relief that the telegraph clerk turns to the manipulation, not of his "key," but of the instrument probably well worn and respected, which lifts him out of the sphere of care and toil into realms of sweet, yet not inactive, forgetfulness, making him for the time being a simple votary at the shrine of Amphion or Apollo. With the laudable object of adding to its music library, the St. Cecilia Orchestral Society has announced a grand vocal and orchestral concert for Friday, February 20th, at the Forester's Hall, Wilderness Row, Old Street, E.C. Efficient and well trained, the society's previous displays have met with a large measure of appreciation and success. We have no doubt similar good fortune awaits them on the occasion of their next appearance in public.

Electric Supply in Liverpool.—The Electric Supply Company having modified the terms of their proposal for the extension of the area of supply, a special meeting of the Watch Committee was held last week to reconsider the application. By a majority the committee declined to remove any of the restrictions that are embodied in the order now in force, or to agree to more favourable terms. The company consequently remain in the same position as before. It is believed that the subject will be discussed at the meeting of the council on Wednesday, as there is a feeling that the committee are making a mistake in this matter.

Tenders Wanted.—For improving the electrical communication throughout the County Lunatic Asylum, Stafford, for the Committee of Visitors. Personal application to be made to the Clerk of the Works, at the Asylum, who will point out and give all information as to the amount and character of the work to be done. Tenders to be delivered by February 20th, addressed to the Chairman of Committee, Mr. James Tilson, clerk to the visitors.

The West India Cables.—The recent interruptions to the West India and Panama Company's cables, to the eastward of Jamaica, have elicited from the *Bermuda Colonist* an article upon the necessity of establishing between the Bermudas and the West Indian islands telegraphic communication. Such connection is recommended not only on account of the benefit likely to accrue to Bermuda, but in view of the advantage offered by a duplicate route to the West Indies.

Submarine Research in the Pacific.—Our attention has been called to an article in the *New York Herald*, which gives an account of a surveying expedition carried out by the U.S. Government between Acapulco, the Galapagos Islands, and Panama. The Fish Commission steamer *Albatross* has been detailed for the work, under the direction of Professor Alexander Agassiz. One of the most interesting of the points to be investigated is the question whether the Caribbean sea has at any remote period had any connection with the waters of the Pacific. It has been argued that the deflection of the Atlantic Equatorial current to the southwards caused a stoppage of the Gulf Stream, and assisted in placing Europe under glacial conditions, consequently a flow westward, through what is now the Isthmus of Panama, would have had the same effect.

The Berlin Electro-technical Society.—It is said the number of members of this society is 1,345, of whom 1,023 are resident in Germany, and the remaining 322 live in various foreign countries.

Failure of an Electric Lighting Company in Madrid.—In consequence of the Ministry of War having revoked the contract entered into with the Sociedad Matriteuse de Electricidad, this old-established association has found itself compelled to suspend its service of electric lighting. This is announced in a circular issued by the syndicate informing its clients of the failure of the undertaking. The factory at Buenavista, the first constructed in Spain for this particular business, has been closed, and gas has replaced, in the Ministry and its dependencies, the electric light, which has been in service since 1882.

Gas and Electricity in Berlin.—A German contemporary says that, at a recent meeting of the Berlin municipality, it was stated that, notwithstanding the development taking place in electric lighting, the consumption of gas had greatly increased.

Lighting in Cassel.—The *Elektrotechnische Zeitschrift* declares that the announcement made in French and English journals that the central station to be erected at Cassel by Messrs. Siemens and Halske is to be laid out for distribution on the five-wire system is incorrect.

A New Year's Dinner.—On Saturday last, Mr. Ronald A. Scott, M.I.E.E., entertained 200 of the poorest children in Acton to a New Year's dinner. Afterwards a minstrel entertainment was given by members of the works.

Twyford Abbey, Middlesex.—The contract for the electric lighting of this well-known historical mansion has been placed in the hands of Mr. Ronald A. Scott, M.I.E.E., of Acton Hill, W. The installation will consist of about 200 lights, and the power will be derived from a gas engine. Storage batteries, to run the full number of lights, will also be fitted.

Conversazione.—On Monday; February 16th, the first of what we hear will be a series of conversaziones, is to be given by Mr. and Mrs. Hammond at the Electrical Standardising, Testing and Training Institution, Faraday House, Charing Cross Road. This institution was recently founded by Mr. Hammond, with the assistance of a Board of Control, consisting of Lord Crawford (chairman), Lord Castletown, the Hon. Reginald Brougham, Mr. Francis Ince, Mr. W. O. Smith, and Mr. Hugh E. Harrison, who also acts as principal, and has just moved into the spacious premises built for it in Charing Cross Road, to which the appropriate name of Faraday House has been given. It is interesting to note that this institution is a revival and extension of the old Hammond College, at which so many men who now occupy prominent positions in the electrical profession received their early training.

The Old Students' Association.—An ordinary general meeting will be held at Finsbury Technical College on Wednesday, February 18th, 1891, at 8 o'clock, when a paper will be read by Duncan Pearce, member (hon. treasurer), entitled, "From College to Factory." (The contributor's experience in the so-called departments of theory and practice.) (*a*) Giving the present defections of both from an ideal. (*b*) Suggestions for making up the deficiencies, with the object of "making manufacture a profit and pleasure."

Personal.—Mr. E. Garcke, formerly manager and secretary of the Brush Electrical Engineering Company, Limited, has been appointed a managing director of that company, and Mr. B. Broadhurst succeeds him as secretary.

Mr. Orlo. V. Thomas, A.I.E.E., has resigned the position of managing electrical engineer to the Taunton Electric Lighting Company, Limited, and has been appointed by the Crown Agents for the Colonies to take charge of the installation at Singapore.

Mr. Muirhead on Telephones.—Mr. Erskine Muirhead delivered a lecture of French telephones before the Glasgow Philosophical Society on Wednesday evening.

Quite English you know.—Mr. W. N. Colam, A.M.I.C.E., a gentleman prominently connected, we believe, with the Society of Engineers, has, apparently, been starring in the States. At the inaugural dinner of the Boston Electric Club last month, he made an oration and was complimented by a Dr. Austin, as having given in his entertaining address more English electrical news in ten minutes than the English technical journals had told them in as many months. We have read the published speech of Mr. Colam, and it mainly consists in flattering allusions to Boston, which he declares to be the most English-like city he had visited in that country. Still we learn two things from Dr. Austin, first, that we have long had in our midst an authority on electrical matters who has hitherto been unrecognised, and secondly, that the English technical journals require nearly a year to do what an Englishman on the spot can do in a few minutes. We would suggest that Mr. Colam be engaged to visit the States periodically, to deliver a ten minutes lecture, but that we fear English technical journalism would then be at a lower ebb than ever.

The City and Guilds of London Institute.—Mr. H. R. Kempe has been appointed examiner to this Institute for the year 1891-2, in the subject of Telegraphy and Telephony. The rules of the Institute do not allow the examiners to hold office for a longer period than five years, hence Mr. W. H. Preece, F.R.S., who has hitherto acted as examiner, ceases after the present year to hold that appointment.

Cardew's Earthing Device.—We will reply to "N. S." in our next issue.

NEW COMPANIES REGISTERED.

Wanzer and Defries Patent Safety Lamp Manufacturing Company. Limited. — Capital, £25,000 in £5 shares. Objects: To acquire the business of Wanzer, Limited, and to manufacture and trade in cooking and heating apparatus, safety and other lamps, electric lighting apparatus, &c. Signatories (with 1 share each): *T. D. Bear, 113, Queen Victoria Street; *J. H. Burt, 143, Cannon Street; *J. E. Bochmer, 4, Bury Street, St. Mary Axe; *D. C. Defries, 101, Farringdon Road; W. B. Fricker, 60, Darenth Road, Stamford Hill; W. Radford, 225, Upper Thames Street; T. T. Bonhote, 10, Eaton Rise, Ealing. The signatories denoted by an asterisk and Mr. J. Browne Martin are the first directors; qualification, £250 in shares or stock; remuneration, £500 per annum, and 2½ per cent. of the net profits available for dividend on the ordinary shares. Registered 27th ult. by Munns and Longden, 8, Old Jewry.

Shropshire Electric Light and Power Company, Limited.—Capital, £25,000 in £10 shares. Objects: To carry on at Shrewsbury and elsewhere the business of an electric light and power company in all branches. Signatories: *T. S. Eyton, 50 shares; *J. Allan Bratton, G. B. Lloyd, *R. Maddox, *J. A. Lea, J. D. Porta, all of Shrewsbury, and *H. Robinson, of Towyer, Merioneth, 20 shares each. The signatories denoted by an asterisk are the first directors; qualification, £200 in shares or stock; remuneration, £100 per annum divisible. Registered 30th ult. by Chester & Co., 36, Bedford Row. Registered office, 9, The Square, Shrewsbury.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Orient Electric Light Company, Limited. — The annual return of this company, made up to the 28th November, was filed on the 27th ult. The nominal capital is £5,000, divided into 20 shares of £250 each. Thirteen shares have been taken up, upon which £100 per share has been called. The calls paid amount to £1,300.

D. Hulett & Co., Limited (electrical engineers, lamp manufacturers, &c.).—The annual return of this company is made up to the 29th September, 1890. The nominal capital is £35,000, divided into 6,900 ordinary and 100 founders' shares of £5 each, 4,100 of which are considered as fully paid up. Upon 1,900 shares the full amount has been called and paid.

Holmes & Sons, Limited (engineers, electricians, &c.).—Under an agreement of 22nd November, this company will take over the engineering business carried on by James Holmes, George Thomas Holmes, and F. R. Holmes, at Norwich. The consideration is £10,500, payable £6,000 by the allotment of 600 fully paid preferred shares, and 600 fully paid ordinary shares, and the balance of £4,500 in cash. Registered office: Prospect Place Works, Castle Meadow, Norwich.

J. & S. Roberts, Limited (ironfounders, mechanical and electrical engineers).—An agreement of the 3rd December provides for the purchase by the Company of the business of Messrs. J. & S. Roberts, of West Bromwich, the consideration being £57,693 9s. 7d., payable £27,150 in fully paid preference shares, £30,000 in ordinary shares, credited with £6 as paid up, and £543 9s. 7d. in cash. Registered office: 68 and 70, Great Bridge Street, West Bromwich.

Marine and General Automatic Company, Limited (automatic electrical tell-tale apparatus).—The registered office of this company is situate at 6, Great St. Helens.

Plenty & Sons, Limited (engineers, electricians, &c.).—An agreement of 1st December provides for the purchase by the Company of the business of Plenty & Son, of the Eagle Iron Works, Newbury, Berks. The consideration is £11,874, payable £7,134 in cash, and the balance in fully paid shares. Mr. E. P. Plenty is appointed managing director for five years at a salary of £300 per annum.

CITY NOTES.

City and South London Railway.

A special general meeting of the shareholders of this Company was held at the offices, King William Street, E.C., on Tuesday, to consider a Bill, which had been deposited in Parliament, by which powers were sought to construct an extension of their line from the City to the Angel at Islington. The chairman, Mr. C. G. Mott, presided.

The Secretary having read the notice convening the meeting, and the Solicitor having given the gist of the chief clauses in the Bill, from which it appeared that the construction of the railway will be identical with that of the City-Stockwell line, and that the capital to be obtained is £660,000 in £10 shares.

The Chairman said that the meeting was called simply to consider whether they would proceed with the Bill which had been provisionally introduced into Parliament for the construction of an extension of this (the City and South London) line from King William Street to the Angel at Islington. It had never been the desire of the directors of that company to proceed with anything in connection with that line at all hastily. They had from time to time, as the holders knew, been asked to go for various extensions; but except the small one at the Clapham end, which they had obtained powers for last year, they had declined such proposals up to the present time. Their desire was rather to consolidate and work their railway satisfactorily before they proposed to extend it. That had been the view the directors had taken all along; and last year they declined this very line (the Islington) when proposed to them. The result was that they were threatened with another Bill—viz., the Central London—in which the promoters proposed to take and occupy the ground, which would have prevented the City and South London Railway from ever being extended into the City of London. Some of the best traffic for a railway of this kind was to be had ultimately from the busy portions of the City, and it did not appear desirable that their road should be permanently blocked so that they could never go for that traffic. On that account they thought it wise that notice should be given this season for a Bill to obtain for them the road into the City at any time they desired to go there. He thought this line could be carried out at a comparatively small expense per mile, and would go through one of the very busiest traffics they could well have in the City. It would go by the Bank, Moorgate Street, and the City Road, and so far as directors could judge it would pay quite as well as, perhaps better than, their existing line. He would rather that the matter had been postponed, but it did not appear to the directors safe to do so at the present moment, and they thought they had better obtain the Act. As to the exact time of carrying it out, and the mode, whether as part of the capital of the existing line, or as a separate concern, these were matters which, if the Bill was obtained, the shareholders would have to decide for themselve at a later date. That was their position now. The directors would have postponed any further action if they could have done so safely, but they thought that it was desirable in the shareholders' interests that the Bill should be obtained if possible, and that the line would be a good one. The great object of a line of that kind was this; morning and evening there was a very large rush of traffic into and from the City, as much as their line could take, but during the middle of the day the trains were not full. This was the experience of all Metropolitan railways, more or less, and their great object in order to make a good dividend was, as far as possible, to fill up these midday trains. Now the effect of another line, such as the Islington extension, would be that they would largely improve the midday traffic on their existing line, and the latter would improve the midday traffic upon the former. Therefore, they would have a better chance of a dividend on their existing line, if a line such as the proposed one were working. It was on account of these facts that the board were disposed to recommend that the company should go on with this Bill. The immediate effect of their proceeding had been that they had prevented the Central London Company from occupying the ground. They had altered their Bill, but if they (the City and South London) withdrew theirs, they would leave the ground again unoccupied. As regarded the City-Stockwell railway, they had as yet only been working for six weeks. On a new line like that they had had a great many difficulties to contend with in the working of an undertaking which, as the shareholders knew, marked an era in the history of railways in this country. A service such as they had started, and hoped to still further develop, had never been attempted on any railway. With the exception of small portions of the District Railway service no complete railway had run trains at the same rate or number as this line was running, and he thought they had reason to be extremely satisfied on the whole with the working of their electrical line. They had seen many paragraphs in the papers complaining of breakdowns. They were, unfortunately, very strongly before the public at the moment, and notice was taken of everything on that line in a way which was not the case with other railways. They had run up to the present time about 11,000 trains. During that period they had had with their engines, which had been the chief causes of delay, 18 failures in running. He did not think they would say that was a large number out of 11,000 trains run. The number of trains working on their line was very large, and it was quite impossible that such a large number should be run without some accidents occasionally. That there should have been only 18 failures of engines run was altogether creditable to the electrical system. They were doing their best to reduce that number, and get rid of failures, if possible, altogether. That they should be able to do so did not seem very likely, looking at the history of human inventions; but they would so minimise the delays when they occurred that the public would feel no inconvenience. The result of the above-mentioned paragraphs had been that many people who would have travelled with them had supposed that the line was stopped and did not go, and the traffic had been damaged. He was satisfied from what he saw now, however, that they had a steadily-improving traffic and a satisfactory result from it. The expenses of working, so far as electricity was concerned, had turned out satisfactorily, and were quite equal to what they expected so far as economy was concerned. On the whole, the prospects of the line were by no means bad. As regarded the new Bill, the directors were quite in the shareholders' hands in the matter, but he thought they would be wise to let the Bill go on, obtain the powers, and deal with the question of using them as they might think fit later on. He moved that the Bill, which had been read to the meeting, be approved.

Mr. Hubbard seconded the resolution. Some opposition being raised on account of the expense incurred in getting the Bill, the Chairman said that it was not an expensive Bill to get through Parliament, and might not cost more than £1,500. The directors had promoted it rather reluctantly, as a protection to the shareholders. There would be considerable risk in withdrawing the Bill, but if the shareholders thought it would be wise to do this, they should say so.

A Shareholder thought they should not extend the system till the existing line had been made to pay.

Another Shareholder, who represented £75,000 of stock in the company, said that it appeared to him that the so-called junction between the existing line and the one proposed was, in fact, no junction at all. It was merely proposed to connect the lines by a foot subway, so that what the Chairman had said about occupying the ground would hardly be the case, for unless there was an actual junction it was still open to any other company to ask for a junction with the rails of the new line, and power to enter its terminus. He had not seen the plans until then, and would like to have an opportunity of considering them. The shareholders knew little or nothing about the matter, and had had no opportunity of considering it, and he thought it would be well to adjourn the meeting for a week, to give them an opportunity of looking into it.

Some discussion arose on this proposal.

In answer to a question, the Chairman said that the proposed capital of the new line was larger than that of the existing one—£660,000 against £600,000. This was because it would probably be necessary to pay heavily for station sites in the City.

Another Shareholder asked whether a junction between the existing and proposed lines was possible, and

Mr. Greathead, the engineer to the line, replied that it was. The proposal to adjourn to the general meeting on the 24th was then put and carried, and a desultory conversation ensued, during which the Chairman, in answer to a question as to why the line was not worked on Sundays, said that they had to feel their way. The delays and difficulties were all capable of remedy, and were being remedied, but they could not do everything in six weeks. The staff were employed night and day, Sunday and every other day, and though there were no trains running on Sunday at present, the time was not far distant when there would be.

The customary vote of thanks was rendered with more than usual heartiness, and this concluded the meeting.

Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited.

The following balance-sheet is annexed to the report which was published in our last issue:—

March 31*st*, 1890.

Dr.	£	s.	d.	£	s.	d.
To nominal capital—						
24,000 shares at £5 each	120,000	0	0			
Less—						
Calls in arrear	1,035	0	0			
				118,965	0	0
To sundry creditors, as under:—						
Vendors	2,424	0	0			
M'Corquodale & Co., Limited ...	1	17	11			
Elmore's Patent Copper Depositing Company, Limited	86	2	8			
Income tax commissioners ...	33	8	6			
Newman, Hays & Co.	20	0	0			
				2,565	9	1
				£121,530	9	1

Cr.	£	s.	d.	£	s.	d.
By purchase of patents as per agreement, dated 4th June, 1889 ...				110,000	0	0
By cash:—						
On deposit	9,000	0	0			
„ current account	646	7	6			
In hand	4	19	9			
				9,651	7	3
Profit and loss:—						
Balance as per account				1,879	1	10
				£121,530	9	1

Profit and Loss Account from 6th June, 1889, to 31st March, 1890.

Dr.	£	s.	d.
To general office expenses	63	19	2
„ Salaries, wages, and directors' fees	1,431	2	1
„ Stationery, printing, and advertising...	39	18	1
„ Patent charges	511	3	0
„ Solicitor's charges (estimated)	20	0	0
„ Rent	37	0	0
„ Exhibition Expenses	14	4	2
	£2,117	6	6

Cr.	£	s.	d.
By interest	213	7	2
„ Transfer fees	24	17	6
Balance	1,879	1	10
	£2,117	6	6

We have examined the above accounts with the books and vouchers of the company, and certify the same to be correct and in accordance therewith.

Pixley & Co., *Chartered Accountants, Auditors.*
24, Moorgate Street, E.C., 24*th December*, 1890.

Balance Sheet, 31st December, 1890.

Dr.	£	s.	d.	£	s.	d.
To nominal capital—						
15,000 priority shares of £5, fully paid	75,000	0	0			
9,000 founders' shares of £5, fully paid	45,000	0	0			
				120,000	0	0
To sundry creditors				47,025	12	4
Profit and Loss—						
Balance, as per account ...				152,167	0	11
				£319,192	13	3

Cr.	£	s.	d.	£	s.	d.
By purchase of patents...	110,000	0	0			
Less—						
Amount reserved from sales of patents	30,000	0	0			
				80,000	0	0
By sundry debtors				22,722	12	0
By sundry securities, as under—						
Elmore's French Company, 33,250 shares of £2 each	66,500	0	0			
Elmore's Austrian Company, 31,075 shares of £2 each ...	62,150	0	0			
Do. do. in debentures	50,000	0	0			
				178,650	0	0
By cash—						
At banker's (on deposit)	37,500	0	0			
„ (current account) ...	148	11	3			
In hand	43	6	8			
				37,691	17	11
By office furniture, fixtures, &c. ...				128	3	4
				£319,192	13	3

Profit and Loss Account from 1st April to 31st December, 1890.

Dr.	£	s.	d.	£	s.	d.
To Balance brought forward				1,879	1	10
„ Directors and auditors' fees, salaries, &c.				1,900	10	7
„ Maintenance of patents and legal charges				1,270	10	3
„ Rent, rates, and taxes				360	13	4
„ Stationery, printing, and advertising	40	15	4			
„ Exhibition expenses	10	6	1			
„ Travelling expenses	20	7	11			
„ General office expenses	86	13	9			
				158	3	1
„ Balance carried down				222,772	19	11
				£228,341	19	0
„ Interim dividend of £4 per share on 15,000 priority shares, paid December 8th, 1890				60,000	0	0
„ Directors' percentage of profits under Clause 72 of articles of association				10,605	19	0
„ Balance carried forward to balance sheet				152,167	0	11
				£222,772	19	11

Cr.	£	s.	d.	£	s.	d.
By Net proceeds of sales of French, Austro-Hungarian, and German patents	257,750	0	0			
Deduct—						
Amount transferred to patents account	30,000	0	0			
				227,750	0	0
By interest				516	14	0
By Transfer fees				75	5	0
				£228,341	19	0
By Balance brought down				222,772	19	11

We have examined the above accounts with the books and vouchers of the company, and certify the same to be correct and in accordance therewith.

Pixley & Co., *Chartered Accountants, Auditors.*
24, Moorgate Street, E.C., 20*th January*, 1891.

The second ordinary general meeting of Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, was held last Thursday at Cannon Street Hotel, an account of which appeared last week, Sir John H. Morris, K.C.S.I., Chairman, presiding.

Mr. Shurmer, Secretary, read the notice convening the meeting.

The Chairman said: Gentlemen, the conditions and prospects of the company, as they stood on 31st December last, are set forth at such length in the report and accounts which has been circulated to the shareholders, that there is not very much for me to say on the present occasion. I may, however, congratulate the shareholders on the realisation of the hopes held out by me at the first general meeting of this company, held in October, 1889, when I stated that the directors had the fullest confidence in the value of the Elmore inventions, and that by declining to negotiate for the sale of the foreign patents until the success of them had been proved in this country, we should be able to obtain much better prices than if we disposed of them at once, which has proved to be the case. The success of the Elmore inventions has, I think, been clearly shown by the English company in this country, and we are now in a position to calculate and estimate pretty clearly the value of our patents for the various countries for which we are prepared to dispose of. We have already, as you are aware, during the past year disposed of the patents for France and Austro-Hungary and Germany, and have thereby acquired a considerable sum, from which we have paid £4 a share to the priority shareholders, and propose now to pay another £1. We are also hoping during the present year to dispose of patents for two or three other countries, and if our hopes are realised we expect to obtain thereby a sum which will enable us to pay another £5 to the holders of priority shares. I wish now, gentlemen, to say a few words on the issue of £50,000 worth of debenture stock by the French Elmore Company, which we have agreed to take from them. It has been remarked to me by more than one shareholder that they saw no reason why we should have agreed to take this large amount of debentures from the French company. On the formation of the French company it was found to be of the greatest importance, not only in the interest of the French company, but also to our interest, to secure the services of M. Secrétan, which could not be done without at least £50,000 more working capital being raised. We agreed to advance this sum provided we were satisfied with the nature of the security offered to us. This was that the debentures should be secured by a first floating charge on the whole of the assets of the French Company, that they should pay interest at the rate of 6 per cent., and that the amount advanced, namely, £50,000, should be repaid within three years, that is to say, by 1st January, 1894, or within any shorter period, at the option of the French Company, and that they should be paid off at the rate of £105 for every £100 of stock. We consider these terms to be favourable, and as in our opinion the security was good and it is very much to our interest to promote the interest of the French Company, we agreed, and your directors are of opinion that the security offered for these debentures is very good, and that the debentures are a thoroughly safe investment. Applications had been made to us by shareholders of the French and of our own company to take up a portion or the whole of these debentures. We propose, therefore, to issue a circular to our shareholders, and to the shareholders of the French Company, offering them these debentures on the same terms as those on which we have accepted them ourselves, and I can only add that we shall be thus in possession of a further amount of funds, which will enable us to pay a further cash dividend to the holders of priority shares. I trust, therefore, that the action of the Board in agreeing to take up these £50,000 of debentures will meet with your approval. I will proceed to notice briefly the balance sheet and the profit and loss account appended to the report. We will first of all take the profit and loss account. If you refer to the credit side you will see that the first item is the net amount received by the company from the sale of its French and Austro-Hungarian patents, namely, £257,750, from which we have deducted £30,000, to represent the original capital value of the patents sold, leaving a net amount, after adding items for interest and transfer fees, of £228,341 19s. The item representing director's fees is in accordance with the articles of association. Owing to the large number of patents we hold the charges for maintenance and legal charges amount to a considerable sum—namely, £1,270. After allowing for sundry working expenses, there is a balance carried down of £222,772. Out of this amount we have already paid an interim dividend of £4 per priority share, which absorbed £60,000, and under clause 72 of the company's articles of association the directors are entitled to £5 per cent. of the net profits of the company, after payment of a dividend of 10 per cent. per annum upon the priority share capital, and this amount works out at £10,605. This may appear very large; at the same time I must point out to you that it is the amount fixed by the articles of association. It is for work done, and, although some of you may consider that the work we have done is inadequate, I can assure you that this business has caused us a great amount of trouble and anxiety. Strictly speaking, we are entitled to receive this amount in cash, but I need hardly say we do not in any way intend to insist on this. It may be distributed to us partly in cash and partly in shares and debentures, as may hereafter be found most convenient to the company as well as most conducive to the interests of the shareholders. We shall be prepared to take it in any way the shareholders may determine. The balance carried forward is £152,167. We will now take the balance sheet. On the credit side we find that the purchase of patents accounts is credited with £110,000, which we have reduced to £80,000 by writing off, as I have already explained to you, £30,000, to represent the original capital value of the patents sold. Sundry debtors, amounting to £22,722 have since the accounts were made up been practically wiped out. The securities next shown are the shares of the French and Austrian Elmore Companies and the debentures of the Austrian Company, representing part of the purchase money for sale of patents to those companies. These shares are here valued at their nominal value of £2 each, and the debentures at £100 per cent., whereas the shares stand at a considerably higher price in the market; and as the works of the subsidiary companies advance the shares will probably rise considerably in value. The French company's works are being rapidly pushed forward. The contractors are under a penalty to complete the same at the end of May, and the factory will, according to the report of Mr. Secrétan, be in operation by the end of June next. The Austrian Company, of which I am the chairman, has also selected admirable works, ready built, in Germany, and should these be secured and the installation of the company's plant and machinery take place as soon as is anticipated, there is every hope of its getting to work very shortly after the French company. Cash in hand and at the bankers at the date of the making up of the accounts amounted to £37,691, making a total on the credit side of the balance sheet of £319,192. This was balanced by (1) the share capital, which amounts to £120,000; (2) the sum due to various creditors, amounting to £47,025. The latter item may require a little explanation. The chief items comprised under this head represents principally the expenses of underwriting, forming and bringing out the French and Austrian companies, the greater part of which has since been paid; secondly the percentage due to the directors, as shown in the profit and loss account, and on which I have already dwelt, and thirdly the item of income tax. I will be very glad to the best of my ability to answer any questions that may be put to me in regard to them. There is only one other point on which I wish to say a few words. I shall be very glad indeed, either now or at some other time, to be favoured with the views and advice of the shareholders on the realisation of the securities held by this company. You will recollect that the matter was taken up and noticed particularly in the circular that was issued to you on November 13th last. In the last four or five paragraphs of that circular this matter was specially dealt with, and it was there stated that the provisions of the articles of association render it difficult to distribute shares held by this company except by way of reduction of capital. In fact, until those articles are altered it is not possible for us to distribute the shares and debentures in the same way as we distribute cash as dividends. In that circular it was proposed, and you were informed, that the directors had received a suggestion from several large shareholders for the formation of a trust company to which these shares should be sold, and who would pay us back either in cash or shares of that company. At the end of the circular it was stated that in the event of the necessary arrangements being satisfactorily made a prospectus would be sent out. The question still remains in abeyance. There are three courses open to us. First, the formation of an Elmore Trust Company; secondly, that we should hold the shares ourselves and realise the profits from them and distribute them to the shareholders; and, thirdly, that we should take measures to alter the articles of association, and thus become empowered to distribute these shares and debentures to the shareholders just in the same way as if they were cash. It is a matter that will require careful attention on the part of all of us; and it is a matter in which I shall be glad to be strengthened by your advice. The board are willing to take the shareholders fully into their confidence, and as far as I am personally concerned, I shall be glad to be guided by your advice. In conclusion, the chairman moved the adoption of the report and the accounts.

Mr. JOHN MACFAELAN seconded the rcsolution.

Mr. HOSTER referred to the property which the company possessed, and stated that the intrinsic value of the founders' shares was at least £30. He and some of his friends, who considered that the surplus profits should be divided amongst the shareholders, had had an interview with the board, and as the result he begged to propose that the directors be requested to take such steps as might be considered necessary to enable them to make the distribution of the company's securities.

The SOLICITOR (Mr. Hays) pointed out that Mr. Hoster's amendment really amounted to a distribution of the assets of the company, and under Article 109 they had no power to do.

Mr. RENDELL thereupon proposed that the directors be requested to consider, and, if necessary, be advised as to the practicability of making the distribution on the lines suggested by Mr. Hoster, and that, pending a further meeting to be called to consider the matter, the discussion of the report and accounts be adjourned.

Mr. CHANCE seconded the proposition.

The CHAIRMAN, in answer to a question, explained the difference between the total amount realised and the net proceeds of the sales of patents, which was stated to be about £100,000. This sum, he stated, had been expended in the work done and in the formation and the underwriting of the foreign companies mentioned in the profit and loss account.

Mr. FREDERICK L. RAWSON made a few remarks with reference to the disposal of the patents; after which

Mr. RENDELL's amendment was put to the meeting and negatived by 21 to 17. The original motion was thereupon put and carried.

The Chairman next moved: "That a dividend of 20 per cent., or £1 per share, less income tax, be paid on February 4th next, upon the priority share capital, making, with the interim dividend of £4 per share paid on December 8th last, a total dividend of 100 per cent. for the nine months ending December 31st last."

Mr. EDWARD J. CARSON seconded the resolution, which was agreed to.

The Chairman said it was the wish of the directors to consult the interests of the shareholders in regard to the realisation of the company's securities; therefore, he was quite ready either to call a special meeting to consider the question or to confer with a committee of shareholders.

After some discussion, it was decided to leave the matter in the hands of the board, with the view to calling a special meeting at a subsequent date.

The retiring directors (Messrs. William Elmore, George Holmes and John Macfarlan) were re-elected, as were also the auditors (Messrs. Pixley and Co.)

The following resolution, which was passed by a general meeting on December 29th, was confirmed:—

"That once at least in every year the board of directors shall lay before the company in general meeting a statement of the income and expenditure for the past year, made up to December 31st, then last past, instead of to March 31st, as provided in clause 113 of the company's articles of association."

A vote of thanks to the chairman and directors terminated the proceedings.

Anglo-American Telegraph Company, Limited.

THE ordinary general half-yearly meeting of the above company was held on Friday last at Winchester House, the Marquis of TWEEDDALE being in the chair.

The SECRETARY having read the notice convening the meeting and the minutes of the last preceding one, which were received as correct,

The CHAIRMAN rose to move the adoption of the report and accounts. He referred in the opening part of his speech to the loss which the company had sustained through the retirement of the chairman, Lord Monck, who had joined the company as chairman 17 years ago, and asked the shareholders to join him in a cordial wish that their late chairman might live long to enjoy the repose which his long, active and useful life had made him so worthy of. He believed that the manner in which the board had the vacancy created by his resignation would meet with the shareholders approbation, and that in appointing Sir Albert Leppoc Cappel, one of their directors, they had chosen the best man they could get. The distinguished position he had held in India, crowned by occupying the highest post in connection with telegraphs in that country both submarine and land, and the honour bestowed on him when retiring from the service showed that he would be a valuable acquisition to the company. Having referred to his own appointment as chairman, he turned to the accounts and report. The gross receipts were £161,986, and the total expenses £56,142, the former being somewhat larger and the latter somewhat less than the previous year. Traffic receipts, for instance, showed an increase of £3,027, while total expenses connected therewith had decreased £2,470. Then they had had a windfall in the hiring of the ship *Minia*, which had added £1,500 to their receipts, and by carrying forward somewhat less than they had brought forward last year they had been able to pay a dividend of one-eighth per cent. higher, making £2 17s. 6d. for the whole year. The reduction in total expenses was rendered still more satisfactory by the fact that both under repairs and renewals there was a very large decrease. The total of ordinary repairs was less by £6,919, while almost the whole interest on the renewals fund was appropriated to increasing that fund, which now amounted to the large sum of £980,000, and if they estimated their securities at their selling prices, it would be something over a million. Working expenses were more than this time last year by £4,499, which was mainly, but not exclusively, due to the offices which they had found it desirable to open in New York, and other offices of less important character, and agencies in other parts. They were aware that they were exposed to a very active competition for the Atlantic traffic, and when that competition took the shape of establishing offices in different parts of this country, the United States, and abroad, it was indispensably necessary that they should pursue the same policy, for it was proved beyond doubt that if a company established an office in a town the traffic went to that office, so that, if they wished to maintain their present traffic and improve it, they must at the very least do what their competitors were doing. He thought it not impossible that the increase which he had referred to might have further increased during the present half-year. This increase in traffic did not appear a very large one, but it was an increase upon another very considerable increase, for the increase last year had amounted to over £26,000. At the same time, they would have been very glad if the present increase had been a larger one, and they would have been very glad to have obtained a larger share of traffic between this country and America, but they could not lay to themselves any blame for not having done their best. They nad done all that was in their power to render their service as efficient as it possibly could be. When their lines were all open they were unrivalled for regularity and speed, but there were times when owing to their having land-lines they were exposed to interruptions on both sides the ocean during the storms which prevail in the winter months, and these interruptions caused much annoyance to themselves and those who favoured them with traffic. These interruptions were far more numerous on the other side than on this, and they had been for some time seeking a remedy. He hoped that before they met again he would be able to report that the interruptions on the other side had been less, and that the means they hoped to adopt to reduce them had been carried into effect. Although other causes than their efficiency might operate in favour of certain lines, he would lay down the maxim that in the long run the traffic would flow over the lines whose service was the best done, and therefore they might look forward to a further improvement in their traffic. An improvement had commenced some time ago, had been continued for the last six months, and he hoped would characterise the current six months. Speaking of the lawsuit in which the company was engaged, he said it had been suggested at a meeting of the Direct Cable Company the other day that they had not been as active as they might have been in bringing the suit to a conclusion. He did not think there was any justification for any such idea. The suit was commenced in 1886, but the first decision—a judgment in their favour was not given till the 9th of January, 1888. The matter was appealed, and on the 19th of March, 1889, a judgment adverse to them was given. They had lodged the appeal with the Council of State on the 3rd July, 1889, and on the 28th March, 1890, the French companies' defence was entered, and though the case had not yet been put on the roll, no doubt it would come up for judgment in a reasonable time, after which there would be no delay in hearing, and the decision being given. The chairman concluded by moving the adoption of the report and accounts, and that a dividend be declared of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, making a total of £2 17s. 6d. and £5 15s. on the ordinary and preferred stock respectively.

Mr. REEFORD wanted to know whether there was any prospect of the deferred shareholders getting anything.

Mr. LEAHY thought they had very little cause to congratulate themselves on the working of the company for the last year. Their chairman was correct that they were unrivalled for speed and regularity when all the lines were open, but as they were more often interrupted than their competitors, they stood at a disadvantage. The interest paid to stockholders depended largely on the interest paid by management to customers, owing to the competition of the "Commercial." His custom, for example, was of more importance to the company than the company was to him, for at any moment he could move and get another very large customer to move over bag and baggage to the enemy. The Commercial Cable had opened offices in Dundee, Bradford, and other places. Why did not they do the same. Returning to interruptions, he read a long list of interruptions that had recently occurred, and suggested that they should do away with land lines altogether and run a "Direct" cable in opposition to the "Commercial" right up to the Hudson River to New York. He concluded with a threat to withdraw his custom, which would make a difference of $\frac{1}{4}$ to $\frac{3}{8}$ths upon the entire Anglo stock, and a hint that new blood was wanted on the board.

Mr. WOOD asked about the law suit.

Mr. JACKSON recalled the time when the late chairman took the helm, and when the company was receiving a handsome, though not an excessive dividend. As to the present slight increase he was afraid it was more due to immunity from accident than to increase of traffic. Referring to the gentleman who had threatened to withdraw his custom, he said it was inconceivable that the seven pool cables could not ensure a more uninterrupted business than the Commercial two. He also thought that new blood was wanted on the board, and complained against the practice of plurality of directorships. How was it possible to get out of stagnation and want of progress by the aid of a gentleman who had a share in the direction of 16 different companies, over several of which he was chairman, among them being one of the greatest in the country—the North British Railway Company. If their chairman were to devote himself eight hours a day to the management of these companies he could only spare 20 minutes a day to companies of their magnitude. Looking at the fact that their youngest competitor was paying 7 per cent. upon its capital, and putting by 5 to 6 per cent. per annum to redeem debentures, they ought to do better than they were doing.

Mr. HUMPHREY spoke on behalf of holders of deferred shares. 40 per cent. of their capital received no dividend, while another part received 6 per cent. Why might not the deferred shareholders have the interest on the reserve fund appropriated to them in the coming half-year, £28,000 would be one per cent., which to a vast number of shareholders would be much better than nothing at all. The deferred shareholders ought to be considered, and the 6 per cent. preference stock should have been got rid of by purchase, conversion, or some other means.

The CHAIRMAN, replying, said that Mr. Reeford had asked concerning the deferred shareholders. That involved the question of dealing with the renewal fund. It had always been recognised that a million was the very least they should have at their credit in regard to the age of their cables, their condition, and the necessity of renewing them some day or other. Still, if they went on putting by as much as they had done last year, they might be able to give the matter their consideration. Mr. Leahy's grievance was a perfectly legitimate one, though as regarded one of his criticisms, they had already given orders for the establishment of offices at the two places he had mentioned, and contemplated establishing them in other places where a paying traffic was likely to be obtained. No doubt the remedy for interruptions was to do away with land lines altogether, as Mr. Leahy had suggested, though the marine lines might be better looked after, for the lines on the English shore, though nearly as much exposed as those across the water, were but rarely interrupted. They had, however, before them a scheme, if not for running cables into New York, of coming to some arrangement which would ensure them an uninterrupted communication with the city. Replying to Mr. Jackson's criticism of himself, denouncing pluralism of directorates, he had never sought for any position he occupied, and the business to which Mr. Jackson referred formed only a small part of the business he discharged during the year. Only recently he was invited to be chairman of the county council of his native county, and though everybody knew how much he was occupied—and there were many competitors for that very busy and occupied post—it was thrust upon him, and he accepted it. After some further remarks, he put the resolution, which was seconded and carried.

The MARQUIS of TWEEDDALE was then re-elected chairman, and afterwards Mr. Cyrus Field, who retired by rotation from the board of directors, was re-elected also.

The auditors were reappointed, and a vote of thanks to the chairman concluded the meeting.

The India-Rubber, Gutta-Percha and Telegraph Works Company, Limited.—Subject to audit, the company's accounts to 31st December last show the following result:—

Brought forward from 1889	£41,236
Nett profit for 1890	65,334
	£106,570
Less interim dividend paid in July, 1890, 5 per cent.	20,800
	£85,770

The directors have resolved to add £25,000 to the reserve fund, and to recommend a further dividend of 5 per cent. (making 10 per cent. for 1890), carrying forward £39,970.

The Electricity Supply Company for Spain.—This company is issuing £75,000 6 per cent. mortgage debentures at 98. The company was formed in 1889 with an ordinary share capital of £100,000 to erect a central electricity supply station at Madrid and to supply electric light there under a concession. This supply station has been erected and is regularly supplying electricity to the company's customers. The ordinary share capital was all subscribed and is fully paid, and the money now asked for is required for the extension of the company's operations.

Hastings Electric Light Company.—A very satisfactory report was presented at the annual meeting of this company held on Wednesday night, a dividend at the rate of 5 per cent. per annum, as recommended by the directors for the past nine months, being declared. It was stated that the company would have to expend £2,000 to meet the requirements of the Board of Trade consequent upon the application for a provisional order under the new Electric Lighting Act. The company are now in treaty with the directors of the St. Leonards Pier for the lighting of the structure, and there are three churches waiting for the light.

Woodhouse and Rawson United, Limited. — The directors have declared an interim dividend at the rate of 15 per cent. on the ordinary shares and 8 per cent. on the preference shares in respect of the profits to the 30th December last.

The Venezuela Telephone and Electrical Appliances Company, Limited.—The coupons on the debentures now due, are payable on presentation at the Consolidated Bank, Limited, 52, Threadneedle Street, E.C.

TRAFFIC RECEIPTS.

Direct Spanish Telegraph Company, Limited. The estimated traffic receipts for the month of January, 1891, are £2,147, as against £2,415 in the corresponding period of last year.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 30th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company, were £4,996.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Jan. 29).	Closing Quotation. (February 5).	Business done during week ending February 5, 1891.	
					Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	98 —101	99 —102	...	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	48½— 49½	48½— 49½	49½	48½
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	85½— 86½	85½— 86½	86⅜	85⅝
2,809,310*l*	Do. do. Deferred	Stock	12½— 13	12½— 13	12⅞	11¾
130,000	Brazilian Submarine Telegraph, Limited	10	11½— 12	11¾— 12¼	12⅛	11 13/16
84,500*l*	Do. do. 5 p. c. Bonds	100	102 —105	100 —103 xd	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	102 —106	103 —107	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	2¼— 2½	2⅜— 2⅝	2⅝	2¼
63,416	Do. do. Non cum. Preference, Nos. 1 to 63,416	2	1½— 2	1½— 2	1⅞	1¾
$7,216,000	Commercial Cable, Capital Stock	$100	104 —105	104 —106	104½	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16— 9/16	7/16— 9/16	9/16	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5 — 5½	5 — 5½	4½	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	11¾	11½
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 4	3½— 4	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	9 11/16	9½
60,710	Direct United States Cable, Limited, 1877	20	10⅛— 10⅜	10⅛— 10⅜	10 7/16	10¼
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14¼	14⅛— 14⅜	14⅜	14⅛
70,000	Do. 6 p. c. Preference	10	14¾— 15¼	15 — 15½	15¼	15 1/16
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	106 —109 xd	108¾	106½
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	105 —108	106 —109	108	107
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅜— 14⅝	14½— 15	14 15/16	14⅝
320,000*l*	Do. 6 p. c. Debentures, repay February, 1891	100	101 —103	... — ... xd	...	...
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	103	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	104½	104
145,300*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	...	...
198,200*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	105	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	100 —102	99 —101 xd	100	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	6¾— 7¼	6½— 7	7	6⅝
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4¾— 5¼	4½— 5	5	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3¾— 4¼	3¾— 4¼	4¼	3⅞
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1¾— 2¼	1¾— 2¼	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 only paid)	5	2½— 3½	2½— 3½	3 7/16	3 1/16
180,227	Globe Telegraph and Trust, Limited	10	9 — 9¼xd	9 — 9¼xd	9 3/16	8⅞
180,042	Do. do. 6 p. c. Preference	10	14⅞— 15⅛	14⅞— 15⅛xd	15⅛	14⅞
150,000	Great Northern Tel. Company of Copenhagen	10	16¾— 17¼	16¾— 17¼	16⅞	16¾
230,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105—108	...	...
9,384*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10½— 11½	10½— 11½	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,800	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½	18½— 19½	19⅜	19
200,000*l*	... Do. ... do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	35 — 37	35 — 37	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	9¼— 9¾	9¼— 9¾	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9¾	9¼— 9¾	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	107 —110	108 —111	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£8 paid)	10	7½— 8	7½— 8	7¾	7½
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅝— 4⅞	4⅝— 4⅞	4 15/16	4⅝
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½— 13	12½— 13	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	10 — 10½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
9,000	Reuter's Limited	8	8½— 9	8½— 9	...	...
209,750	South of England Telephone, Limited, Ordinary Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	⅛— ⅜	⅛— ⅜	...	...
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2¾— 3¼	2¾— 3¼	...	...
3,381	Submarine Cables Trust	Cert.	112 —115	112 —115	115	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	4⅞	...
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	47 — 49	47½	...
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —103	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4	3 7/16	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 95	90 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	8¾	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	98 —101	98 —101	100½	100
30,000	West Coast of America Telegraph, Limited	10	2 — 4	2 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	95 —100	95 —100	...	...
64,174	Western and Brazilian Telegraph, Limited	15	11¼— 11¾	11¾— 12¼	11⅞	11¾
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	7	6 11/16
27,873	Do. do. do. 5 p. c. Deferred	7½	4¾— 5¼	5¼— 5¾	5 11/16	5⅛
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —107	102 —105 xd	...	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	102 —105 xd	105¼	...
88,321	West India and Panama Telegraph, Limited	10	2⅝— 2⅞	2¾— 3	2 15/16	2 13/16
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11¼— 11¾	11¼— 11¾	11⅝	11½
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	11 — 12	11 — 12	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	99 —103	99 —103	...	...
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	3	3½— 4	3½— 4	...	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7⅛—7⅜.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, £1 10s. paid, including premium), 2½—2⅝.—House to House Company (£5 paid), 4¾—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 1¼—1¾.—Manchester Edison and Swan Company, £9 (£1 paid) 11s.—13s.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2⅜—2½.—Preference, 4⅜—4⅝.

BANK RATE OF DISCOUNT.—3 per cent. (29th January, 1891).

THE PROGRESS OF TELEGRAPHY IN 1890.

(From the *Journal Télégraphique*, of Berne.)

FROM a telegraphic point of view, the most important event in the past year was the International Conference of Paris. We have already, in a series of articles published in this Journal, given an account of the labours of this body; we therefore will not revert to the observations made in those articles, chief object of which was to call attention to the modifications effected at the Paris Conference, in the regulations of international service and in the tariffs of telegraphic correspondence. But we believe that it may be of some advantage if we profit by this opportunity to offer a few remarks upon the very notable advancement of the Telegraphic Union.

The inception of this Union dates from 1865, it thus reckoning 26 years of existence. The first meeting, held at Paris, for the purpose of drawing up the first telegraphic regulations intended to organise the intercourse between European countries, was composed of delegates from the German States, Austro-Hungary, Belgium, Denmark, Spain, France, Greece, Italy, Holland, Portugal, Russia, Norway and Sweden, Switzerland and Turkey. After the second conference, held at Vienna in 1868, the Union was extended beyond Europe by the accession of British India and Persia, and in Europe it was joined by Luxembourg, Roumania, and Servia. Three years later Great Britain, which until then had held aloof owing to the fact that the telegraph system was not under Government control, was able to take part in the conference held at Rome in 1871, and the Union then also gained the adherence of the Dutch East Indies. At the conference of St. Petersburg in 1875, the Egyptian delegates made their first appearance. It was, however, at the conference held at London in 1879 that the greatest extension of the Union, to extra-European States occurred, it being joined by South Australia, Brazil, Japan, New Zealand, and Victoria. At the Berlin Conference of 1885, the list of European States was completed by the accession of Bosnia-Herzegovina, Bulgaria, and Montenegro, while the extension of the Union outside Europe included the Cape Colony, French Cochin-China, Natal, New South Wales, Siam, Tasmania, and Tunis. Finally, the Paris Conference of 1890 saw the adherence of the Argentine Republic and the Spanish colonies of Cuba, Puerto Rico, and the Phillipine Islands, bringing the total number of States participating in the Union to 42.

It must, however, be remembered that telegraphy is not exclusively in the hands of Government Administrations; a portion of international communications, and nearly all the important submarine cables are owned by private companies. A considerable number of these associations have conformed to the regulations of the Union, and several have accepted its provisions by formal adherence at the Convention of St. Petersburg. These accessions may be fairly considered as an extension of the Union.

The companies were not officially admitted to international conferences until that of St. Petersburg, in 1875, where seven attended, of which number three notified their adherence. At the London Conference of 1879, the representatives of sixteen companies were present, six joining the Union. At Berlin, in 1885, nineteen companies were represented, and of these nine joined the union. Finally, at the conference held at Paris in 1890, twenty-three companies attended the meetings, eleven signifying their adherence. This progress is all the more remarkable since during the interval between the two last conferences, three of the companies which had taken part in preceding conventions had disappeared, either through the extinction of their concession, or owing to the purchase by Governments of their lines; these companies were the "Submarine," the "Vereinigte Deutsche Telegraphen-Gesellschaft," and the "Hamburg-Helgolander-Telegraph."

The system of submarine communications continues to be extended, but the very important undertakings which were effected during the last few years, in the extension of West African cables, were followed in 1890 by a comparative slackness. In European waters the principal work has been the submersion of 510 knots in a new Anglo-Swedish cable, and the laying of a duplicate cable of about 70 knots between Canéa and Candia. In the seas to the east of Europe, the Turkish province of Yemen has been connected with Perim, and on the east coast of Africa, Zanzibar has been joined on the one hand with Bagamoyo, and on the other, with the island of Mombassa. In the seas to the west of Europe two cables have been laid between Canso (Nova Scotia) and New York, and one was submerged between the Bermudas and Halifax (Nova Scotia); finally a duplicate cable was laid between St. Vincent and Barbadoes. Fort de France (Martinique) was connected with Paramaribo (Dutch Guiana), and Môle-St. Nicolas was placed in communication, by a submarine cable, with Port au Prince (Hayti).

With regard to land lines, there is no event of importance to chronicle; it is only known that the Russian Government is considering the construction of a line along the shores of the White Sea, from Kala to the Norwegian frontier.

It is not to be understood that Administrations have maintained their systems in a stationary condition; the preceding observations refer only to the principal lines. If we enquire into the progress made by each country individually, it will be found that a marked increase has taken place in the lengths of lines and conductors. The latest statistics show that European Administrations have, during the past year, placed at the service of the public 354,259 miles of telegraph lines, comprising 1,025,481 miles of conductors, as against 338,719 miles of lines and 994,406 miles of conductors, giving an increase for the year of 15,540 miles of lines, and 31,075 miles of conductors.

The number of telegraph stations opened to the public has received very considerable additions: the eighth edition of the nomenclature (to appear shortly) of stations gives 75,000 offices, or 15,000 more than in 1887, showing an average of over 3,000 offices per annum.

The number of messages also shows a constant increase. The amount during the year, in Europe alone, reached nearly 200 million telegrams, of which 155 millions were internal and 45 millions international, or 10 per cent. more than in the preceding year. The countries wherein telegraphic traffic reaches the highest figures are—Great Britian, with 65 million telegrams, 58 internal and 7 foreign; France, with 42 millions, 35 internal and 7 foreign; Germany, with 26 millions, 18 internal and 8 foreign; Austro-Hungary, with 13½ millions, 7 internal and 6½ foreign; Russia, with 11 millions, 9 internal and 2 foreign; Italy, with 9 millions, 7 internal and 2 foreign.

The progress in telephonic communications has been steadily advancing. Germany leads with nearly 200 systems and 40,000 subscribers; but in France the advance in improvements to the service and in the increase of systems and subscribers, has been most noticeable since the Government took the telephones into its own hands. At Paris, where on the 1st October, 1889, there were only 6,300 subscribers, at the end of 1890 there were 9,300. Lyon has 800, Marseille 600, Bordeaux 500, Lille 450, Reims 400, Roubaix 350, Tourcoing 300, Cannes, St. Etienne, Nantes, Troyes, and Saint-Quentin, 150 each, and about 30 other towns with from 50 to 100 each, or a total of more than 16,000 subscribers as against 10,000 as published in the last statistics. Interurban communications are also extending throughout France, and we shall soon possess a telephone cable connecting Paris with London.

In reviewing the progress of electricity in general, although we find no record of new discoveries, there has yet been considerable advance in its application to lighting, transmission of force, electrolysis, &c. The struggle between the partisans of alternating and continuous currents continues with about an equal amount of success on either side. It must, however, be admitted that the largest installation of the year is being carried out on the alternating current system; the electro-dynamic machine at Deptford, constructed for the lighting of a large part of London, wiil have an armature of 39·36 feet diameter, and will be run by an engine of 1,250 H.P.; a current of 10,000 volts potential being developed, which by means of a series of transformers will be reduced, at the consumers, to 100 volts.

A considerable amount of attention has been paid to the construction of accumulators, and many important improvements have been effected. Secondary batteries are becoming of more practical application, and we may cite as an example their employment in the central telegraph station at Berlin.

The year 1890 has given us occasion to deplore many losses. M. Auguste Frey, Director-General of the Bureau

International, had scarcely entered upon his new duties when a painful illness removed him from his family and friends. M. Nordlander, Director-General of Swedish Telegraphs, and who represented his country at the conferences of St. Petersburg, London, and Berlin, died on the 27th February. Early in the same month we learned the premature decease of M. de Tornos y Matamoros, for many years a senior official in the Direction-General of Spanish Posts and Telegraphs. He attended the conferences of Vienna and St. Petersburg as Spanish delegate, and represented a submarine cable company at the conference of Berlin. From among the staff of telegraph companies we have to record the death of M. Despointes, electrician to the Submarine Telegraph Company, and of M. Bourdeaux, for long the engineer-in-chief to the same company. Among electricians known to our readers we have to notice the much regretted death of M. Napoli, to whom is due so many improvements in the application of electricity to railways, and we have also to record the death of M. Halske, partner in the firm of Siemens and Halske.

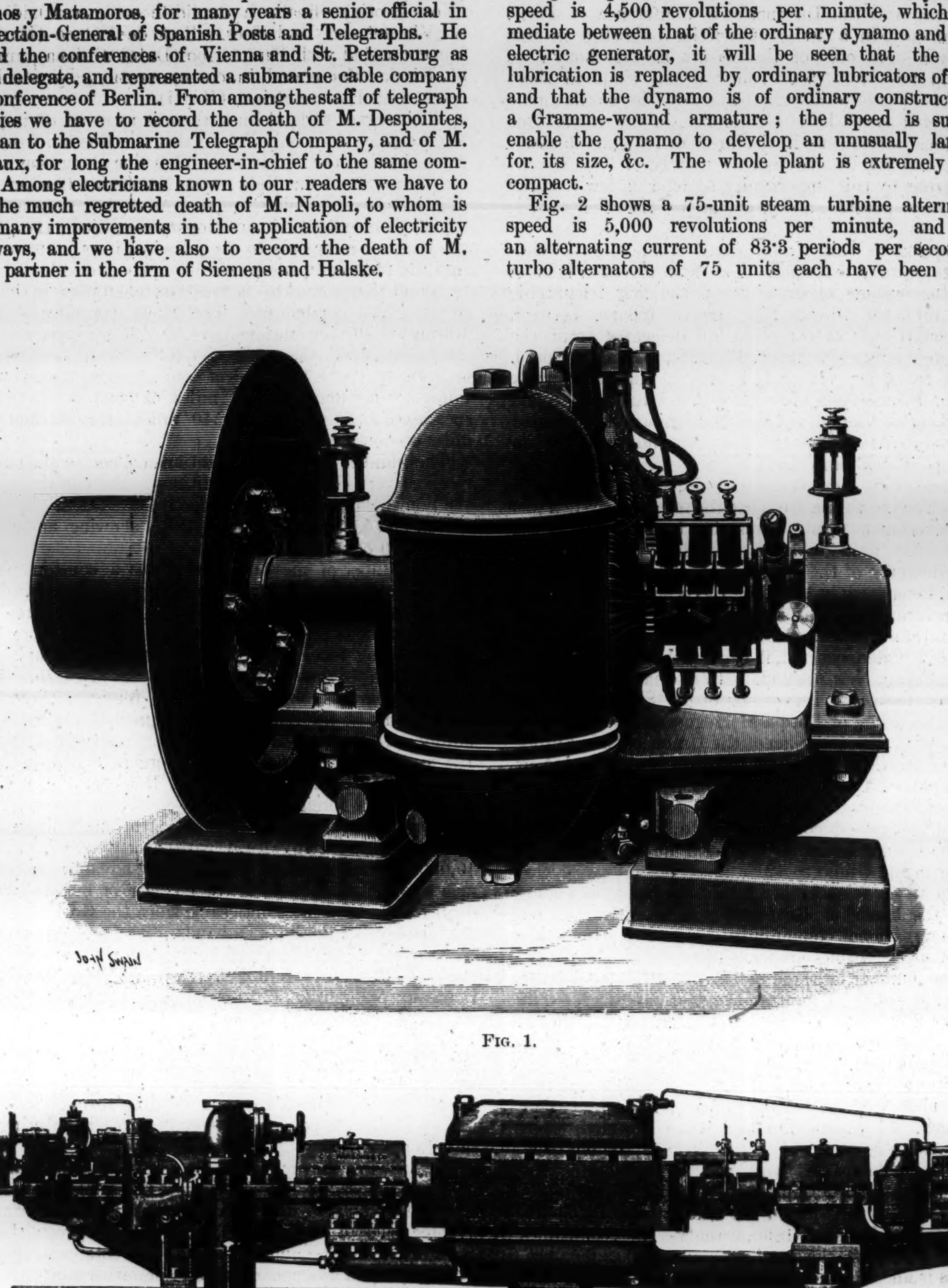


FIG. 1.

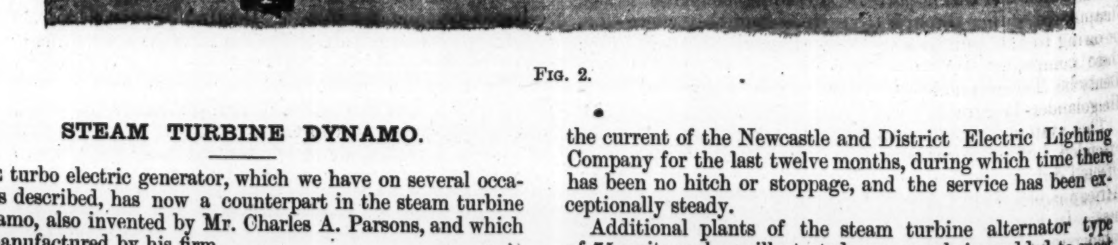


FIG. 2.

STEAM TURBINE DYNAMO.

THE turbo electric generator, which we have on several occasions described, has now a counterpart in the steam turbine dynamo, also invented by Mr. Charles A. Parsons, and which is manufactured by his firm.

As will be remembered, the chief characteristics of the turbo electric generator are that the motor part of the combination consists of a parallel flow compound steam turbine, revolving at an extremely high rate of speed, and coupled directly to a dynamo of special construction; the speed was so high that special bearings and means of lubrication had to be employed in order to obtain a satisfactory result.

Fig. 1 represents a 35-unit steam turbine dynamo, whose speed is 4,500 revolutions per minute, which is intermediate between that of the ordinary dynamo and the turbo-electric generator, it will be seen that the automatic lubrication is replaced by ordinary lubricators of large size, and that the dynamo is of ordinary construction, with a Gramme-wound armature; the speed is sufficient to enable the dynamo to develop an unusually large output for its size, &c. The whole plant is extremely light and compact.

Fig. 2 shows a 75-unit steam turbine alternator; the speed is 5,000 revolutions per minute, and generates an alternating current of 83·3 periods per second. Four turbo alternators of 75 units each have been generating the current of the Newcastle and District Electric Lighting Company for the last twelve months, during which time there has been no hitch or stoppage, and the service has been exceptionally steady.

Additional plants of the steam turbine alternator type of 75 units each, as illustrated, are now being added to meet the increasing demand for light, which now amounts to 8,500 10-C.P. glow lamps.

NOTE ON THE INTENSITY OF TELEPHONIC EFFECTS.

By Mons. E. MERCADIER.

THE intensity of telephonic effects depends chiefly upon the thickness of the diaphragm, its diameter, the intensity of the magnetic field, the form of this field and the induction coils.

The influence of the thickness of the diaphragm has already been investigated (vide *Comptes Rendus*, April 5th and 8th, 1889), and it has been shown that for every telephone of a given magnetic field there is a certain thickness of diaphragm which gives a maximum intensity.

Having determined that thickness of diaphragm which corresponds to the maximum effect, it is possible to vary its diameter, and to discover what size of diameter gives also the best intensity. This result comes from two causes :—

1. The magnetic field of the core only produces a sensible effect within a limited region of the diaphragm. Hence, by increasing the diameter, the inert part of the diaphragm is also increased in area and not the sensitive part.

2. By increasing the diameter, its flexibility is without doubt also increased, and this favours vibration; but, on the other hand, the mass of the diaphragm is also increased, and accordingly there is more difficulty in the way of producing these vibrations for the necessarily limited variations in the magnetic field.

From these considerations it may be deduced, and confirmed also by experiments, that the diameter which produces the best effect ought to vary in magnitude with the intensity of the magnetic field.

Thus it is explained how some telephones with diaphragms of large dimensions, and with magnetic fields relatively intense like the instrument of Gower, Pollard, &c., do not produce greater effects than those instruments which have a weak magnetic field, but smaller diaphragms, such as the telephones of d'Arsonval, Ader, Aubry, &c.

It is hence necessary, if it is desired to obtain with a telephone the maximum effects, to combine suitably the proper thickness with the proper size of diaphragm, according to the intensity of the magnetic field which is at disposal.

The influence of the intensity of the magnetic field is far from being as great as one might be led to believe at first sight.

Very varied experiments have been made on this subject in magnetising the cores of soft iron of the induction coils by means of an electro-magnet, instead of fixing them, as is commonly done, at the poles of a magnet. It is thus easy to produce magnetic fields of very different intensities by causing the current which excites the electro-magnet to vary in intensity. By working in this way it is easy to arrive at a certain limit at which the effect of the telephone does not vary sensibly, this limit being reached when the mass of the iron becomes rapidly incapable, as it were, of absorbing all the lines of force of the field, and more and more of these lines traverse the diaphragm.

This can be tested by scattering some fine iron filings upon the diaphragm, and observing that an increasing portion of the field becomes useless in the production of telephonic effects.

It is necessary, further, to observe that these effects are due to the deformations of the lines of force of the field; that these resist the deformation due to the energy of the waves arising from the voice, according as the magnetic field is more intense, and that this energy is necessarily limited. These remarks apply equally well to the telephone receiver.

The above considerations help to explain the want of success of experiments made with a view to increasing the intensity of the effects of a telephone by increasing the energy of its magnetic field, and why it has been decided in practice only to use apparatus of small dimensions of which the magnets are relatively weak, and which are more manageable.

The influence of the form of the field and of the induction coils has been very much studied. It may almost be said that all the possible forms have been tried. But it is evident that theoretically the form in which the lines of force are perpendicular to the direction of the wire in the coils is the best, other things being equal. This is the form which Mons. d'Arsonval uses in his telephone, and my own experiments upon this subject have confirmed his conclusions. Moreover, the variations in the form of the field are able to be facilitated by the mobility of the field, and this can be increased up to a certain point by the mobility of the magnet and of the cores of the coils. This was demonstrated quite recently by Mons. Aubry by fixing a magnet to a vibrating plate; but there is in this case also a limit which it is not possible to exceed, and which can be determined by experiment.

In summing up the foregoing facts, it seems that the following conditions are those by means of which it is possible to obtain the best results from a telephone, namely :—

1. The mobility of the lines of force of the field should be favoured.

2. The lines of force should be cut by the greatest possible turns of wire of the coils, and perpendicularly to their direction.

3. The thickness of the diaphragm should be diminished until it is just sufficient to absorb the greatest number of lines of force existing in its vicinity.

4. The ratio of that part of the diaphragm which comes under the influenee of induction to the whole of the diaphragm should be increased.

ELECTRIC LIGHTING IN CALAIS.

THE Northern Railway Company of France has recently established an electric lighting installation on a somewhat extensive scale at its stations in Calais. These are three in number—one in the town itself, called the Calais-Central; another on the pier for steamer traffic, called the Calais-Maritime, and a third called the Calais-Triage, where carriages are sorted and trains made up. The distances of the two last-mentioned stations from that of Calais-Central are respectively about 3½ kilometres.

The work at these three stations required very different conditions of lighting; the passenger traffic at Calais-Central necessitated illumination up to midnight; at Calais-Maritime the service is irregular, depending upon the arrival and departure of the steamboats; while at Calais-Triage the greater portion of the work is carried on during the night. It was therefore determined to construct a central generating station at Calais-Central, making the other two receiving stations.

At the central station there are two engines, each of from 150 to 180 H.P. They were built at the works of Messrs. Chaligny and Company. There are four dynamos, each of 27 ampères, at 1,000 volts; two of these are employed on the Calais-Maritime circuit, one on the Calais-Triage, and one is retained as a spare machine. For its own local work Calais-Central employs four low tension machines, each of 200 ampères and 70 volts.

The lines connecting the stations are bare overhead wires of 38 square mm. in section. Some small portions are, however, carried underground, and here the wires are insulated with three coverings of India-rubber. The dynamos at the central station are of the horizontal Gramme pattern, and the machines at Calais-Maritime and Calais-Triage are of much the same type.

The lighting consists of :—

At Calais-Central :
    16 arcs of 6 ampères;
    14 „ „ 12 „
    320 incandescence lamps of 10 to 16 candles;

At Calais-Maritime :
    30 arcs of 6 to 12 ampères;
    200 incandescence lamps of 10 to 16 candles.

At Calais-Triage :
    20 arcs of 12 ampères;
    200 incandescence lamps of 10 to 16 candles.

In addition there is at Calais-Maritime, for the service of the hotel and the refreshment room, a battery of 160 accumulators, each of 700 ampère-hours.

COMMUNICATIONS FROM AUSTRIA-HUNGARY.

[FROM A CORRESPONDENT.]

On January 26th there was held in the offices of the Anglo-Austrian Bank the constituent general meeting of the General Austrian Electrical Company. After being constituted, the general meeting agreed to take over the central station already erected in Vienna by the firm of Siemens and Halske, for electric lighting and the distribution of power, with its real property in the inner city (6, New Badgasse and Blutgasse), together with all buildings and machinery, the entire net of cables, and the concessions acquired. As a managing board, there were elected for the first term of three years, among others, Prof. Leopold, Chevalier von Hauffe (President of the Austrian Association of Engineers and Architects); Arnold von Siemens (of the firm of Siemens and Halske, in Vienna); Dr. Joseph Rosenthal (engineer of the firm Siemens and Halske); and H. Schwieger (solicitor to the firm Siemens and Halske, in Berlin and Vienna). In the session of the board which followed after the general constituent meeting, Prof. von Hauffe was chosen as president.

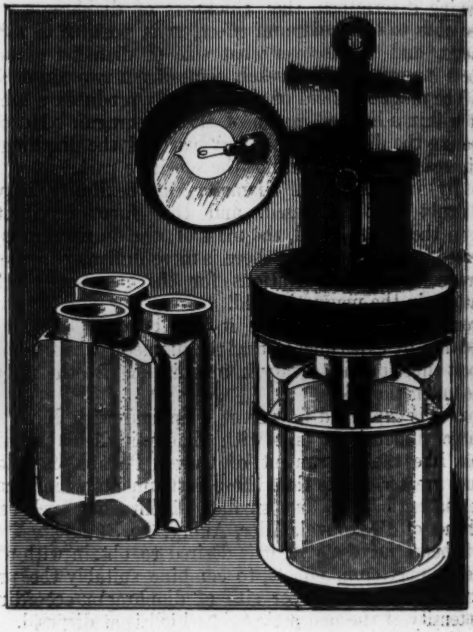
Four electric companies are therefore about to enter into competition in Vienna, *i.e.*, the Vienna Electrical Company, the International Electrical Company, the Austrian General Electrical Company, just founded, and the International Compressed Air and Electric Company, which is to work on the "Popp" system, and which has just obtained a concession in Vienna.

The last-mentioned company will probably not be able to begin its activity very early, and the definite grant of the concession voted by the Municipal Council has encountered a delay. In the session of the council on January 23rd, the conditions for the supply of compressed air and electric current from the proposed "Popp" central station were discussed, and objection was taken to section 2. According to this paragraph, the company is to possess the exclusive right of the installation of the electrical leads and compressed air pipes, whilst in all the three electrical works already existing in Vienna the consumers are at liberty to have their leads and internal arrangements installed by any maker, which does in fact take place. It was therefore proposed in like manner to refuse this exclusive right to the Popp Company, and the proposal was energetically supported by several members. Herr Kareis is not in favour of granting to the company the exclusive right of fitting up motors. Still the company had the most experience, and could therefore supply compressed air motors most advantageously. In this manner the cheaper consumption of air might make the dearer apparatus of the company more remunerative than motors obtained elsewhere. The company would have a certain responsibility if it could penetrate into the interior of houses. Dr. Richter moved that section 2 should be sent back for more definite expression. This motion was approved of, and the entire affair was postponed *sine die*.

THE PHOTOGRAPHERS' ELECTRIC LAMP.

Amateurs of photography, writes a correspondent in *La Nature*, are aware of the importance attached to the lighting of their laboratory during the development of the plates. The little red glass lantern lighted by a petroleum lamp often leaves much to be desired, the lamp may smoke or burn low, and if this happens at the moment when a plate is immersed in the developing bath it causes great inconvenience. M. Radiguet, the well-known electrical instrument maker, has invented a very ingenious little apparatus, consisting of a little incandescence electric lamp, burning under a red glass, which furnishes the photographer with the light required for his operations. The accompanying figure shows its construction. The apparatus consists of a globe containing three bichromate elements, connected in tension; they supply an incandescence lamp of five volts. The three elements are shown empty in our engraving, by the side of the complete apparatus; they can be easily cleaned and filled with liquid. The zincs employed for the battery are mounted in such a manner that it is very easy to change them when they are used up. A central support enables them to be quickly submerged in the liquid, in order to make the battery work, and to be drawn out when the operation is concluded.

The reflector, containing the electric lamp, can be moved round the apparatus; moreover, it turns on an axle which enables it to be directed downwards, and thus to light up the developing vessel. For the purpose of photographic operations, the reflector is supplied with a movable red lantern—a lantern of any other colour may be substituted for this, or it may be suppressed altogether when the lamp is to be used for ordinary lighting.



To use the apparatus, we have merely to lower the metal triangle placed on the upper part of it, the zincs are then submerged in the liquid, and the light is produced instantaneously; by raising it again the lamp is immediately extinguished. The intensity of the light is regulated by lowering this triangle gradually; it is better not to bring the incandescence to too great a height, as the filament might break; this precaution is especially necessary when the liquid is new. The photographer's lantern may be employed for other purposes than the one we have indicated. In order to light the lamp without the battery the apparatus is provided with a double terminal for the conveyance of the current. M. Radiguet has designated his apparatus by the name of *electro-photophore*—it is very ingenious and well-planned.

ELECTRIC LIGHTING IN THE CITY.

After experiments extending over some 12 or 13 years, arrangements have at length been concluded for the public lighting of the City of London by electricity; and on Tuesday the great work of installation was formally commenced.

The ceremony consisted in starting the underground works, by constructing the principal junction box to be used for connecting the mains of the two contractors, the object being to make the two systems inter-dependent, so that in the event of a serious accident occurring at either of the generating stations, current will be obtainable from the other stations. This junction box is situated at Walbrook, close to the Mansion House, and the Lord Mayor accepted the task of placing the first stone of the box in position. To mark the occasion a numerous company assembled, among those present besides the Lord Mayor, being Mr. Sheriff Farmer, Mr. Sheriff Harris, the Duke of Marlborough, Lord Thurlow, Mr. Deputy Frank Green (chairman of the Commissioners of Sewers), Mr. Preece, and Colonel Martindale. At the inaugural ceremony and at a luncheon which followed at the Cannon Street Hotel, statements were made explanatory of the work. In laying the stone the Lord Mayor expressed a hope that with the electric light fogs would be prevented, and Mr. Deputy Green claimed that London would soon become the best lighted city in Europe.

In responding to the toast of the Commissioners of Sewers, at the Hotel, Mr. Deputy Frank Green said that it was some years since they had made experiments of lighting the streets by electricity, and although not successful, they had cost about £8,000. He concluded by saying that the Commissioners would render every assistance to the contractors in carrying out the work.

The Duke of Marlborough proposed success to the electric lighting of London.

Mr. Preece said that every means had been taken to place the electric lighting of the City on the greatest lines of security, so that such accidents as had happened in New York would be impossible. It was possible now to manufacture electricity as cheaply as gas, but it could not be distributed as cheaply as gas. If the contracts were carried out as he thought they would be, London would become the best lighted city in the world.

During the day the Lord Mayor and the Chairman of the Commissioners of Sewers were each presented with samples of the cables to be employed, mounted in silver, as inkstands.

We have stated in previous issues that the negociations with the Commissioners of Sewers have resulted in the division of the City into three sections—an Eastern, comrising the whole of the City east of the Mansion House; a Central Division, from the Mansion House to St. Paul's Cathedral; and a Western Division, which takes in the other part of the City west of the Mansion House up to Temple Bar. For the carrying out of the work, contracts have been concluded by the Commissioners of Sewers with the Brush Electrical Engineering Company, Limited, for the central and western divisions, and with the Laing, Wharton and Down Construction Syndicate, Limited, for the eastern division. These contracts provide for the electric lighting of the whole of the streets of the City, partly by arc lamps and partly by incandescent lamps. Provisional orders have already been confirmed by Parliament for the supply of electricity to private consumers in the central and eastern divisions, and similar power is being sought for the western division. Altogether there are to be in the streets 400 arc lamps, of 2,000 nominal candle-power, and 1,000 incandescent lamps of varying candle-power. Every street, lane, court, and alley is to be lighted; and the companies will have what is practically a monopoly of private supply. The cost for lighting the streets is expected not much to exceed £20,000 per annum, and for this it is hoped there will be twenty times the illuminating power now obtained from gas. The Brush generating station is on the south side of the river, and the mains will cross to the City over Southwark and Blackfriars Bridges; while the generating station for the eastern division (Laing, Wharton, & Down Construction Syndicate) will be on the banks of the river between the Custom House and the Tower.

NEW PATENTS—1891.

912. "Improvements in automatic electric locking gear for controlling signals on railways." D. Richards. Dated January 19th.

941. "Improvements in magnetic compasses." A. Bloch. Dated January 19th.

980. "Improved electric signals for railways." W. Walker, M. Walker, J. Sansom and A. Cole. Dated January 20th.

984. "Improvements in telegraphic transmitting apparatus." R. Theiler and G. K. B. Elphinstone. Dated January 20th.

991. "An improved electric percussive rock drill." A. T. Snell. Dated January 20th.

1,007. "Apparatus for separating ores and metals by the aid of electricity." E. Ferraris. Dated January 20th. (*Complete.*)

1,046. "Apparatus for prepaid telephonic messages." R. H. Gould and T. Gottschalk. Dated January 20.

1,049. "Improvements in the manufacture of dynamo-electric machines." S. Z. de Ferranti. Dated January 20th.

1,050. "Improved means for distributing electrical energy." S. Z. de Ferranti. Dated January 20th.

1,051. "Improvements in electrical transformers or converters, and in their manufacture, partly applicable to the manufacture and testing of dynamo and other insulated conductor coils and armatures." S. Z. de Ferranti. Dated January 20th.

1,053. "Improved method for testing the electrical firing gear of ordnance." A. Noble and E. W. Lloyd. Dated January 20th.

1,066. "Improvements in electric blank heaters for forging machines." G. D. Burton and E. E. Angell. Dated January 21st. (*Complete.*)

1,069. "Improvements in globe and shade holders for gas, electric light, and oil lamps, chandeliers, and other similar purposes." J. Brookes and E. G. Ward. Dated January 21st.

1,084. "Automatic throwback for electric indicators." W. H. Jackson. Dated January 21st.

1,114. "Improvements in electric railways and in apparatus for the propulsion of vehicles by electricity." A. Churchward. (Communicated by A. J. Robertson, United States.) Dated January 21st. (*Complete.*)

1,118. "Improvements in folding lamp shades for gas and electric lamps." O. Imray. (Communicated by L. von Orth and E. Breslauer, Germany.) Dated January 21st.

1,122. "Improvements in or connected with incandescent electric lamps." A. D. Raine. Dated January 21st.

1,138. "An improved guard for incandescent electric light globes." W. H. Munns. (Communicated by J. Mino and W. D. Wastfield, United States.) Dated January 21st.

1,173. Improvements in appliances for the transmission of electric energy." Sir W. Thomson. Dated January 22nd.

1,175. "Improved safety ventilating self-lighting gas and electric battens for lighting up theatres and other public buildings." J. Tollerton. Dated January 22nd.

1,176. "Improvements in brush holders for dynamo-electric machines and electric motors." F. M. Newton and T. Hawkins. Dated January 22nd.

1,192. "Means and apparatus for propelling boats and rafts on waterways by means of electrical energy." O. Busser. Dated January 22nd.

1,200. "Electric contact for locks." W. H. Colson. Dated January 22nd.

1,202. "Improvements in electric clocks." M. Devries. Dated January 22nd.

1,251. "Improvements in electrical switches." E. Atkins and W. Atkins. Dated January 23rd.

1,279. Improvements in and relating to electric signals for railways." E. C. Wiley, J. A. Dickey and N. B. Ainesworth. Dated January 23rd. (*Complete.*)

1,318. "Improved means or arrangements for electric distribution." A. W. Cutler. Dated January 24th.

1,329. "An improved electrical heating and cooking apparatus." W. H. Munns. (Communicated by C. Talmage, United States.) Dated January 24th.

1,332. "An improved insulator for electric wires." W. H. Munns. (Communicated by F. Miro, West Indies.) Dated January 24th.

1339. "Improvements in alternating current electric clocks." E. de Pass. (Communicated by H. C. Spohr, Germany.) Dated January 24th.

1,359. "Improvements in or relating to electrical fire signals." A. J. Boult. (Communicated by C. Dixon and —Fouler, France.) Dated January 24th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

6,492. "Improvements in electric railways." (Under International Convention.) M. W. Dewey. Dated November 2nd. 8d. Relates to electric railways wherein the motors are connected to a line working conductor arranged along the path of the vehicle in series or derived circuit. 20 claims.

6,568. "Improvements in and relating to electrical measuring instruments." H. H. Lake. (Communicated from abroad by M. M. Garver, of America.) Dated April 29th. 8d. Consists more particularly, first in means of preventing a greater radiation of heat from or to one branch of a divided conductor than from or to the other branch, and thus obviating differences in resistance in said branches due to the heating of the material composing them, and second, in means for adjusting the scale so as to cause a percentage variation in the relative lengths of the scale divisions. 2 claims.

6,569. "Improvements in electrical measuring instruments." H. H. Lake. (Communicated from abroad by E. Weston, of America.) Dated April 29th. 8d. Embodies broadly a coil of wire pivoted in the field of a magnet, and carrying an index needle which moves over a suitable scale. The coil assumes an angular position depending upon the difference in potential of the current at the binding posts of the instrument and the deflection of the needle over the suitably marked scale indicates said difference in volts. The principal novel features embodied are the use of oppositely acting springs in combination with the rotating coil, the construction of said springs of non-juductive or non-magnetic material, the devices for tightening or loosening said springs, the guard to prevent catching of the inner turns of said springs over the outer abutments, the arrangement of the scale plate and its support on the pole pieces instead of on the magnet, the construction of said plate and combination therewith of the mirror, the uniting together of the pole pieces, coil and scale plate, so that these parts may be separated as a unit from the magnet, the construction and arrangement of the concentric resistance coils, the novel form of circuit closer, and the disposition of the circuit connections together with other combinations and instrumentalities. 7 claims.

6,811. "Improvements in telephones." W. Vogel and G. G. Calkins. Dated May 2nd. 6d. Claim:—A telephonic transmitter or receiver, comprising a main line coil, a local circuit coil, a soft iron core, and a vibrating armature or diaphragm, substantially as described.

6,956. "Improvements in electric and elevated railways." E. M. Boynton. Dated May 6th. 11d. Consists chiefly of a skeleton tube or tubes supported on suitable columns, and strengthened by circumferential bands, and when electricity is used as a motive power it embraces a novel device for supporting and protecting the electric conductors. 6 claims.

7,003. "Improvements in electric motors." L. Duncan and H. H. Carpenter. Dated May 6th. 8d. Has for its object a construction which shall be relatively of small weight and great efficiency, wherein the revoluble parts shall move at a low rate of speed, thereby dispensing with intermediate gearing or belting, which is necessary where slowly moving machinery is driven by ordinary motors, and also wherein the resultants of the moving forces are evenly distributed throughout the revoluble parts. 3 claims.

7,425. "Improvements in the method of producing alternating electric currents." M. S. Conly. Dated May 13th. 8d. Claims:—1. The described method of producing high tension impulses, in a line circuit, the same consisting in first closing a local battery circuit, including a helix, thereby causing the helix to become electro-statically saturated, then simultaneously opening the electric circuit and introducing the line circuit therein, thereby permitting the electro-static discharge from the helix to traverse the line circuit, substantially as described. 2. The described method of producing alternating electric currents in a line circuit, the same consisting in first closing a local battery circuit, in which is included a helix, thereby causing the helix to become electro-statically saturated, and then simultaneously opening the local circuit, and introducing the line circuit therein, alternately reversing the terminals of the local with the terminals of the line circuit after each closing of the local circuit, whereby the electro-static discharge from the helix will traverse the line circuit in alternately opposite directions, substantially as described.

CORRESPONDENCE.

Storms and Telegrams.

The very able article, so far, by W. Slingo and A. Brooker in your issue of 23rd inst. cannot be otherwise than most interesting to telegraph and electrical engineers, and as it is to be continued, I hope these gentlemen will not fail to deal upon the subject of the A pole *for exposed positions*, but give their candid opinions thereon. Since I introduced this pole in January, 1887, I understand that the government of certain railway companies are erecting them on a very large scale, showing that, under a proper survey, they have proved a success.

If these gentlemen have not seen a line constructed entirely with A poles, I would ask them to inspect such between, say, Daluaspidel and Dava (about 45 miles on the Highland Railway) before concluding their article, when they may find something to enlarge upon, and thus benefit all concerned. I have no doubt that the manager would allow them to ride in the van, for the purpose of this important inspection, if they will only take the trouble to obtain his sanction.

Arthur E. Gilbert.

P.S.—There is also a piece of A pole line from Stanley junction to Pitlochry, on the same railway, which may be equally worth looking at, unless it has been allowed to deteriorate and get out of shape.

January 29th, 1891.

Varying Resistances of Bad Conductors.

In a previous letter I called attention to a supposed discovery made by Mr. Branly, which formed the subject of an article in the *Electrician* of the 23rd ult. At the time I wrote to the Electrical Review I also wrote to the *Electrician*, but they have not published my letter.

That the *Electrician* is published in connection with a certain telegraph interest is I believe openly admitted; but, notwithstanding that this is so, I should have expected that a certain sense of fair play would have characterised the management of the paper, and I think I am only doing my duty in calling attention to the treatment my letter has received.

An observation made during a thunderstorm in 1856 led to researches which resulted in the production of my lightning bridge, which was practically introduced in 1866, and which depends for its action upon a precisely similar principle as that which appears to have been lately rediscovered by Mr. Branly; and, curiously enough, this is the second occasion that I have been very unfairly treated by those connected with telegraph interests in respect to my lightning bridge invention.

That my bridges are efficient protectors is evidenced by the letter of Mr. Haynes, the telegraph engineer of the Bristol and Exeter Railway, which he wrote to the Electrical Review in August, 1882. On the B. and E. Railway there are 110 of my bridges, all of which were doing duty last year, and I have no doubt are doing duty at the present time. 73 of these bridges were supplied in 1867—24 years ago—and 37 in 1872—19 years back. During the whole of the period mentioned they have been acting efficiently, and it has occasionally happened that the passage of a lighting discharge has temporarily produced a path across the bridge of low resistance, which has been at once set right by giving the lightning bridge a few taps. There were at one time several thousands of my lightning bridges fitted to the postal telegraph instruments, but at the time they were supplied there was a disciplinary regulation in force, which did not permit wires in direct communication with the earth to be led into intermediate telegraph stations, and my bridges had to comply with the postal regulations. Now, notwithstanding that this disciplinary regulation was in force, and insisted upon by the electrical department of the Post Office, Mr. Preece read a paper before the Society of Telegragh Engineers in December, 1872, in which he condemned my bridges because there was no direct earth connection, and the remarks I made during the discussion that followed Mr. Preece's paper were suppressed from the published proceedings of the Society.

Now, it unfortunately happened for me that an unusually severe storm occurred in the metropolis shortly after my lightning bridges had been adopted by the Postal Department. The clerk in charge of a district office informed me, that during the time this storm was raging electrical discharges succeeded one another with great rapidity, producing a sound like a continuous cracking of whips, that the composition pipe of the gas burners was melted, and the gas set fire to. Now, as the lightning bridges were not supplied with earth wires to carry away the main discharges direct to earth, and as the discharges were *unusually* severe, they were burnt up after a series of discharges had passed through, and advantage was taken of this circumstance to condemn my bridges. I have no doubt that all these offices are now fitted with earth wires, but I venture to think if another such storm as that which destroyed my bridges should occur, that the lightning protectors now adopted by the Post Office would be destroyed.

S. Alfred Varley.

February 2nd, 1891.

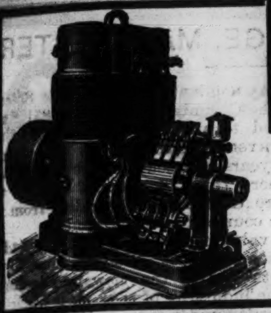
S. Alfred Varley's Article on Crookes's Address.

I thank your correspondent, "N. S.," for his criticism. It is very difficult to paint in words, not capable of misconception, what the mind conceives, especially when an argument involves mental assumptions, and the difficulty is very much increased when one tries to express what he wants to say, very briefly. On re-reading the passage commented upon, I find I have not clearly expressed what was in my mind at the time I was writing the article, and the criticism of "N. S.," so far as it goes, seems to me to be sound, at the same time it is not quite free from ambiguity, and I think it very probable that "N. S." also found some difficulty in expressing verbally what was in his mind when he wrote his letter.

I have dealt with the matter in another communication, as I found I should have to run into some length in dealing with the matter commented upon, and usefully answering the questions "N. S." has put.

S. Alfred Varley.

February 2nd 1891.



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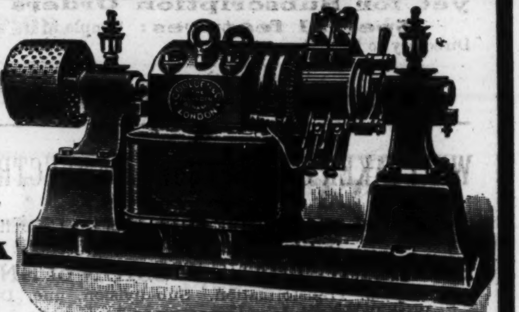

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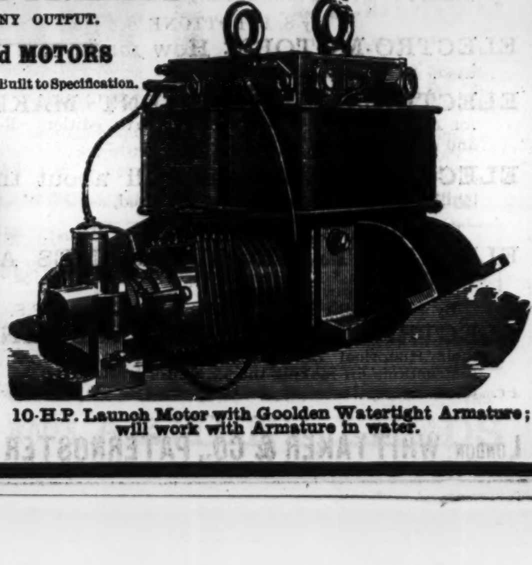

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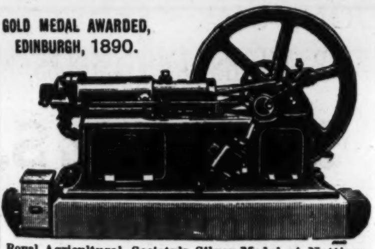

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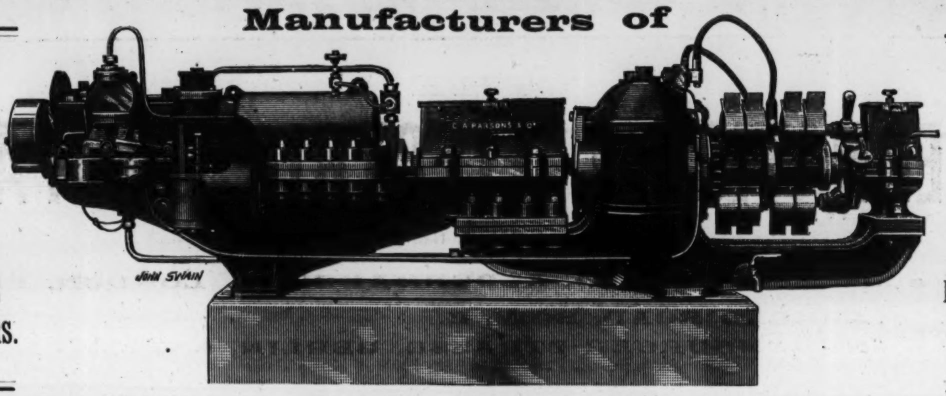

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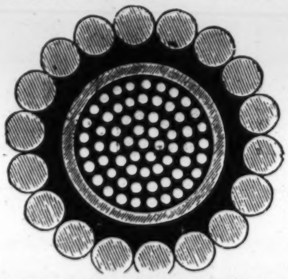

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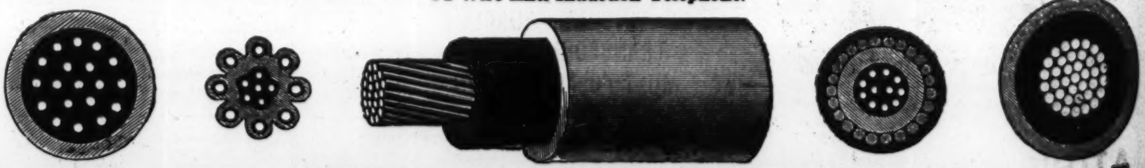

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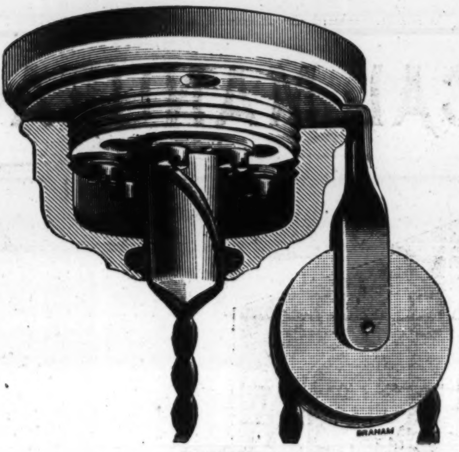

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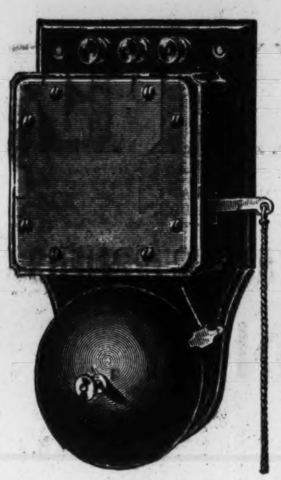

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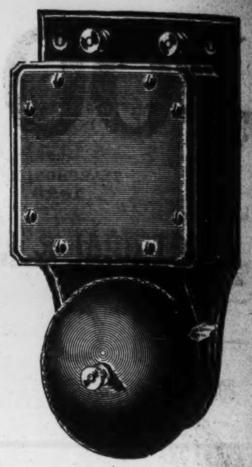

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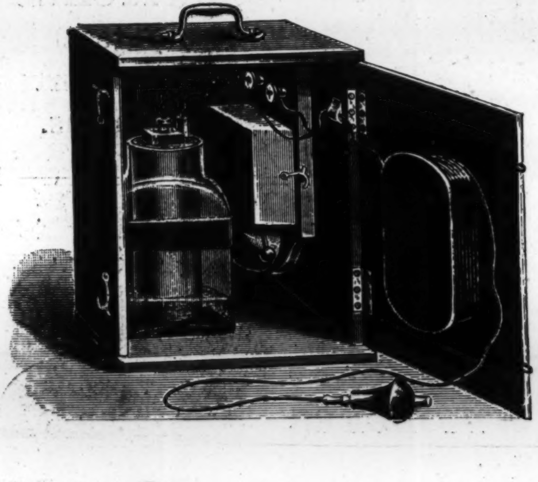

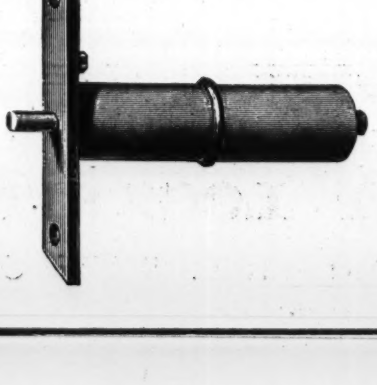

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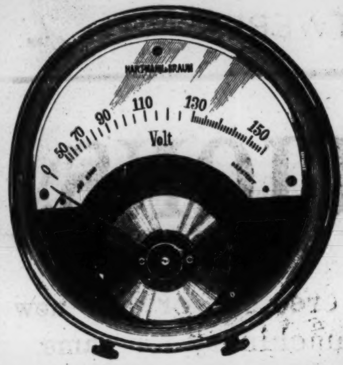

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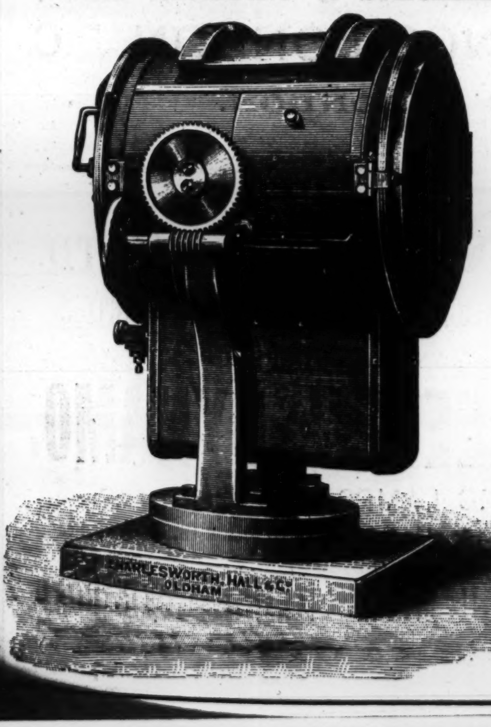

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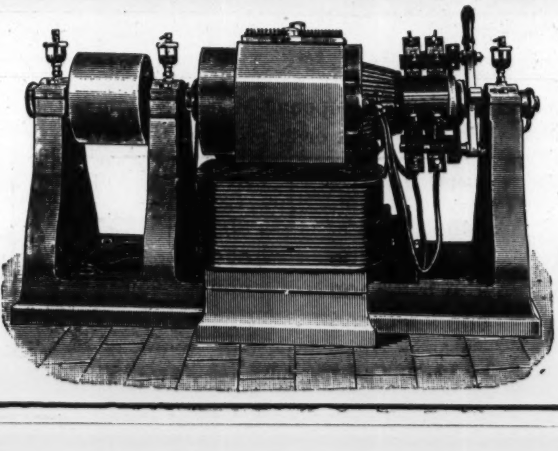

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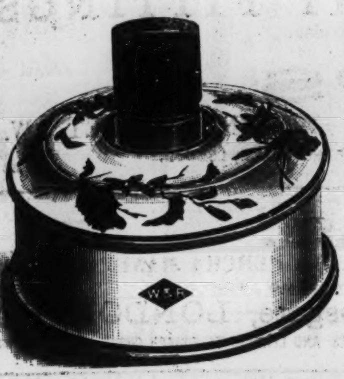

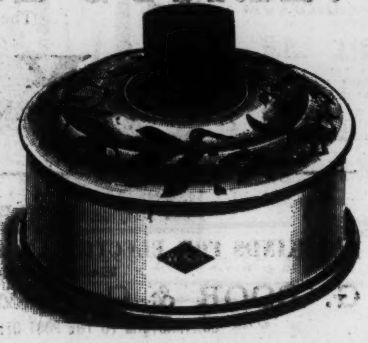

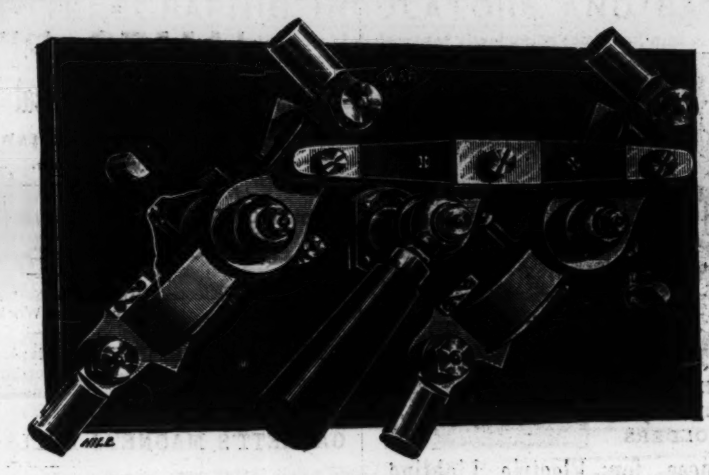

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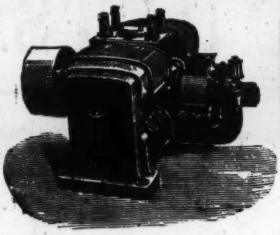

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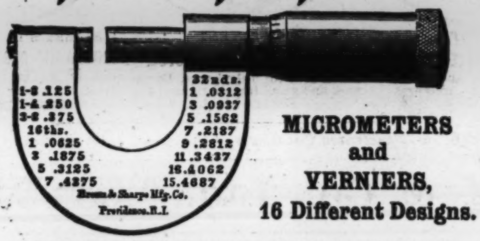

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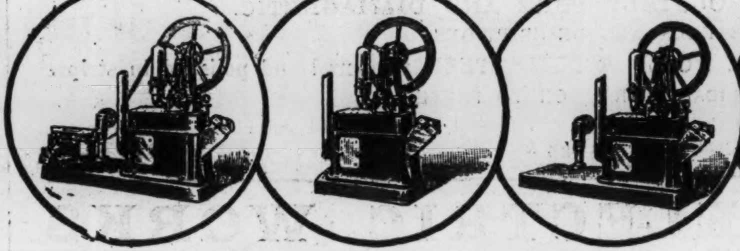

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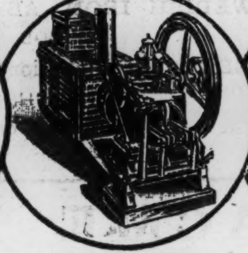

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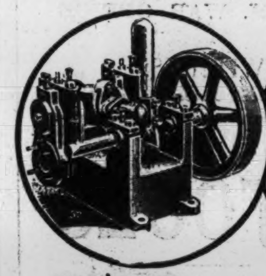

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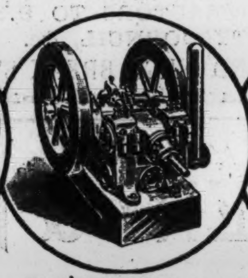

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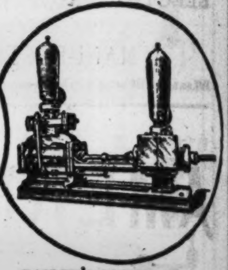

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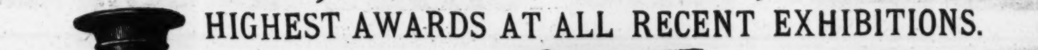

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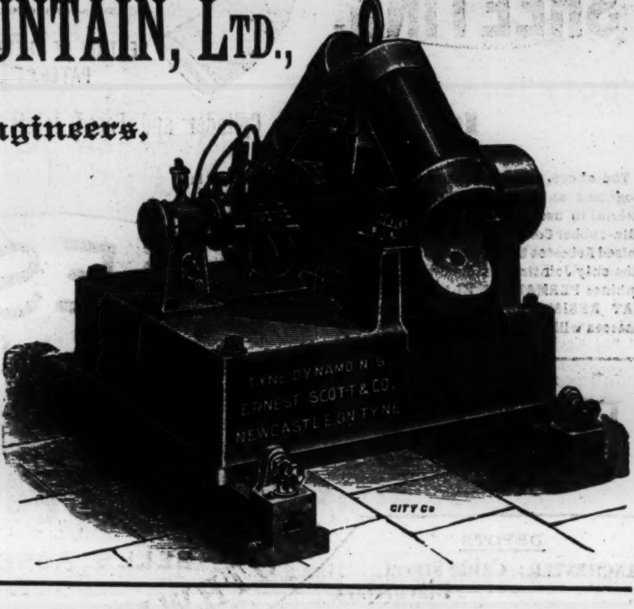

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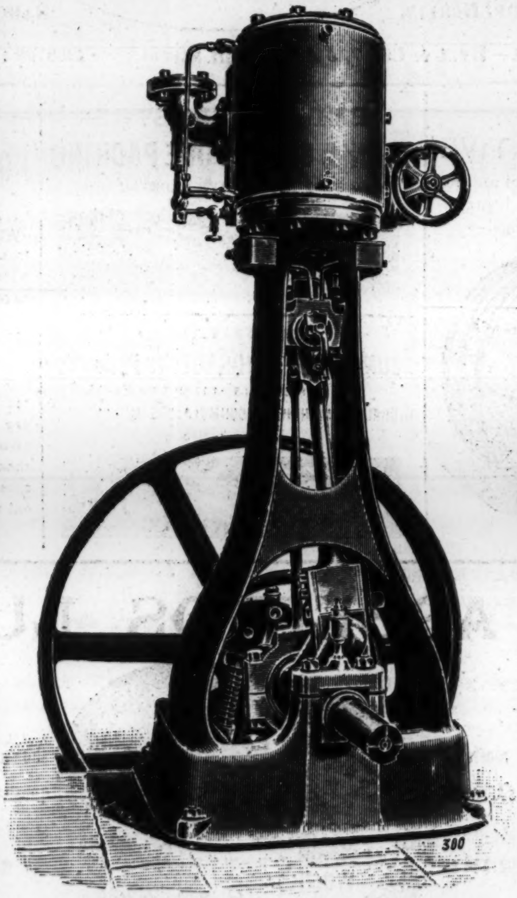

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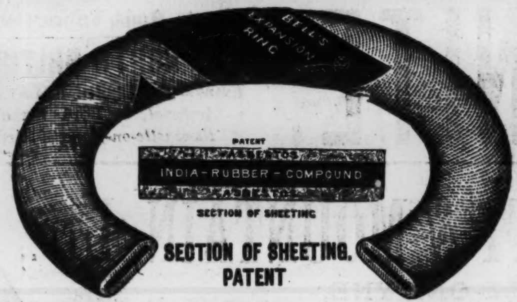

SECTION OF SHEETING.
PATENT

Made from 1-Ply for Cylinder and Faced Joints to any thickness for uneven surfaces.

The above, which can only be obtained from this house, is recognised as the Most Efficient and Economical Jointing Material in use. It is composed of a specially-prepared India-rubber Compound, protected by a covering of Vulcanised Asbestos Sheeting, as shown above, and as it is the only Jointing Material which adequately combines PERMANENT ELASTICITY WITH HEAT RESISTANCE, the advantages it possesses will at once be seen.

The Centre from which the requisite elasticity is obtained will adapt itself to uneven surfaces to which it may be applied, and allow the expansion and contraction to be fully taken up. The covering being of Asbestos Cloth, imparts a protection to the centre and so prolongs its elasticity. For Manhole, Mudhole, Steam Pipe, and Mash Tun Door Joints it is unequalled, and if applied as directed a ring can be used many times over.

BELL'S ASBESTOS Co., LTD.

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Will effectually keep Boilers clean and remove any Incrustation, without injury to the Boiler Plates or Fittings.

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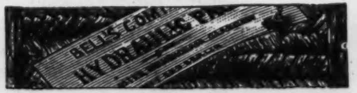

BELL'S ASBESTOS. NON-CONDUCTING COMPOSITION.

Will reduce loss by radiation, and saves 40 per cent. of fuel.

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Is sent out dry in bags therefore cheaper than others sent out wet.

All bags are marked as above

BELL'S ASBESTOS LUBRICANT.

Any customer receiving Oil sold as Bell's Asbestos Lubricant, & Cask, Drum, or Corks not marked as shown, is earnestly requested to forward us sample and particulars of where obtained.

ASBESTOS BELL'S LUBRICANT

Drums are marked as above.

Every Cask is sent out as above.

All Corks are sealed as above.

BELL'S ASBESTOLINE.

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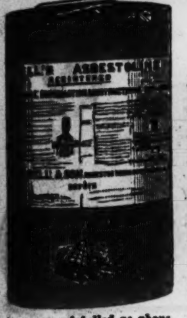


All kegs are labelled as above.

ADVANTAGES OF ASBESTOLINE.

ASBESTOLINE is the most efficient Lubricant for all bearings.
ASBESTOLINE is the cheapest Lubricant.
ASBESTOLINE saves from 50 to 90 per cent. of the Cost of Oil.
ASBESTOLINE is the Cleanest Lubricant.
ASBESTOLINE is favoured by Insurance Companies.
ASBESTOLINE is the most Inodorous Lubricant.
ASBESTOLINE is the safest Lubricant, its flashing point being 700 F.
ASBESTOLINE has beaten all other Lubricants in making trials.
ASBESTOLINE is applicable in and out doors in every climate.
ASBESTOLINE requires no special application.

CONSISTENCY OF ASBESTOLINE.

ASBESTOLINE, to meet all circumstances, is made in four degrees of consistency, A, B, C, and CC.

ASBESTOLINE A, is specially adapted to ordinary Land Engines and Machinery, in and out-door, in this country.

ASBESTOLINE B, a little more solid, is for use on Steamships in temperate climates, also on land when it is desirable to have Lubricant stiffer than A.

ASBESTOLINE C, is for use in tropical climates, both ashore and afloat. It is also invaluable in works in this country when the temperature is high.

ASBESTOLINE CC, is designed for use on calenders, paper machines, &c., where the bearings are heated by steam passing through, and sometimes is advantageously used instead of C.

The reputation of Asbestoline as a lubricant of the highest efficiency in every kind of machinery is established, and it has never been equalled by any other lubricant in the numerous cases of special difficulty in which the best oils are ineffectual. This reputation is growing daily, because it is **based on the experience of thousands of users** under the severest circumstances any lubricant has ever been subjected to, **and not on mere laboratory tests** and professional analysis of insignificant quantities. It is used with marked success in Steel and Iron Works, Collieries, Cotton and Wool Mills, and other Textile Manufactories. In Corn Mills it has proved invaluable on the roller and other modern machines. In Saw Mills, on Machines going up to 5,000 revolutions per minute, its work has never been approached by any other lubricant. On Electric Lighting Machinery, and in Steamships of all sizes throughout the world, the success of Asbestoline is unequalled. Many engines and machines of all descriptions give trouble and show bad results ,both in working and wear, when the system of lubrication has not received due consideration. Engineering firms of the highest standing have given to it their powerful testimony and support.

SUPPLIED IN KEGS, 28 lbs., 56 lbs., or 112 lbs.

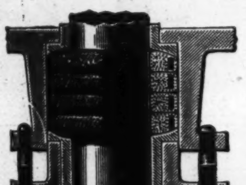
SPECIAL TERMS FOR LARGE QUANTITIES.

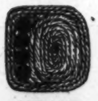
IMPORTANT TO EXPORT MERCHANTS.—One Pound of "Asbestoline" equals 2 gallons of Oil weighing 18 lbs. consequently the saving in freight is very considerable. Liberal Terms are conceded to Export Merchants.

BELL'S ASBESTOS

DAGGER PACKING

Patent.





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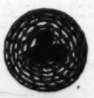
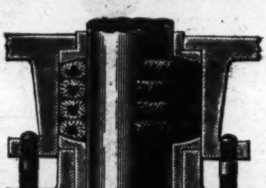


ROUND.



Every 10 feet has label as above, and bears our Trade Mark.

Under this registered title are included the inventions of Mr. Field, and experience has proved them to be **THE MOST EFFICIENT, DURABLE, AND ECONOMICAL PACKINGS** ever made. They constitute such a combination of Asbestos and India-rubber as secures the maximum of elasticity and heat resistance, and they are therefore **UNEQUALLED FOR EVERY KIND OF ENGINE.** These Packings are being universally used by most of the leading Steamship Companies throughout the world for ordinary Compound, Triple, and Quadruple Expansion Engines of the latest type. These Packings are composed of Rolled Asbestos Cloth, but the India-rubber is placed in two forms to suit various cases.

☞ **In ordering, state whether square or round required.** ☜

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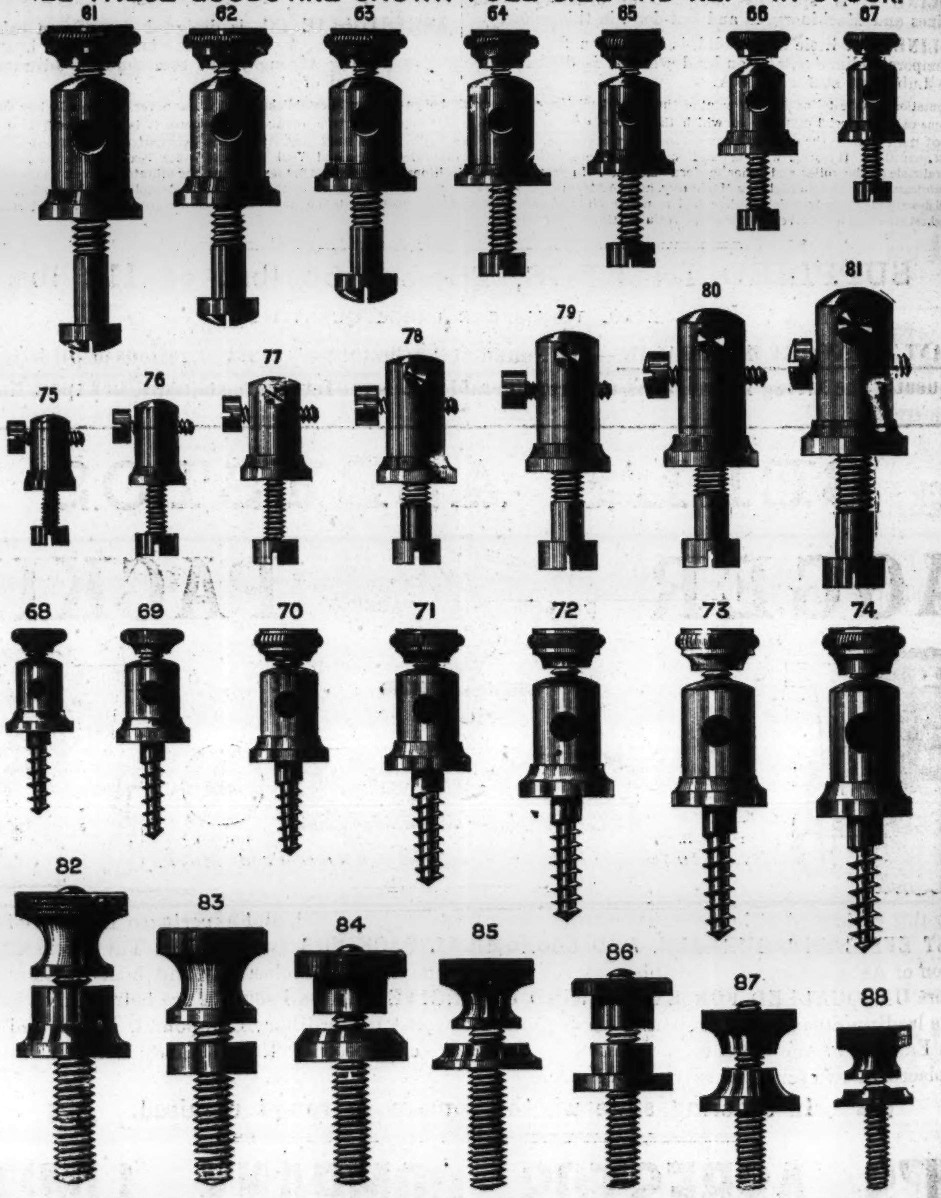

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Price for each Station, with Call-Bell and Battery complete, for lines up to 2 miles.	2	12	6
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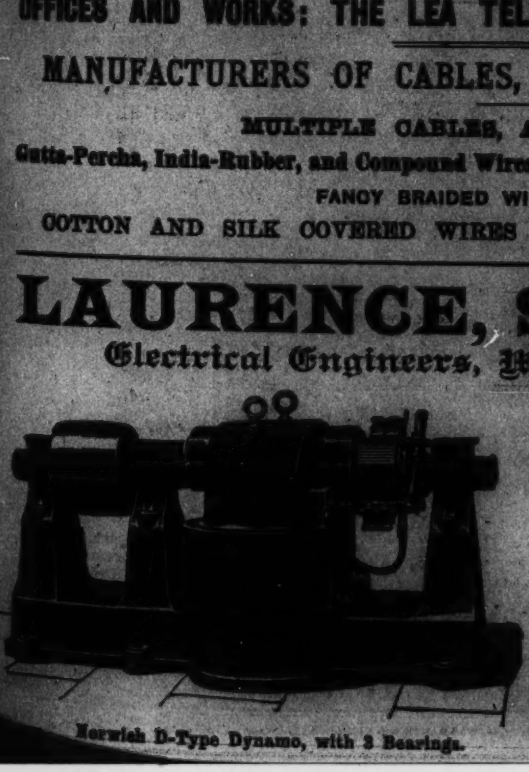

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Printed by E. WRIGHT, 18 and 19, Middle Street, E.C., and Published by the Proprietors, H. ALABASTER, GATEHOUSE & Co., at 22, Paternoster Row, London.